REPORT OF THE CHIEF

OF THE

BUREAU OF ENTOMOLOGY

AND PLANT QUARANTINE

1951

UNITED STATES DEPARTMENT OF AGRICULTURE

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Report of the Chief of the Bureau of Entomology and Plant Quarantine

Agricultural Research Administration, 1951

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 15, 1951.

DR. P. V. CARDON,
Agricultural Research Administrator.

DEAR DR. CARDON: This year has been a very active one for the Bureau. We were confronted with some of the most difficult entomological problems of a generation. At the same time a major reorganization to strengthen our control and regulatory activities was initiated. In addition, much was accomplished in entomological research. High lights of these activities and accomplishments are recorded in the following report for the fiscal year ended June 30, 1951.

Sincerely yours,

AVERY S. HOYT,
Chief.

CONTENTS

THE YEAR IN BRIEF

MANY OF OUR most spectacularly destructive insect pests, favored by the moderate overwintering conditions needed for mass survival, were able in 1950 to build up their greatest summer populations for a quarter century.

General farmers, cotton growers, ranchers, and foresters faced threats of extensive insect damage. The insect outbreaks on many fronts were countered by utilizing the potent insecticidal weapons developed during the last decade. An estimated 232 million pounds of seven of the principal insecticides (technical grades) were used in 1950. Cultural controls and natural methods of suppressing infestations were adopted where possible. The large assortment of new equipment for applying dusts and sprays from the air and ground received a thoroughgoing test.

Outstanding among the Bureau's activities and accomplishments were successful campaigns against grasshoppers, the oriental fruit fly, and the citrus blackfly. The spraying in Colorado to combat the Engelmann spruce beetle was the most extensive campaign of its kind in history. A sharp upswing in grasshopper infestations on western range lands and cropped areas inspired widespread farmer and rancher participation in another large-scale control program. Introduced natural enemies of the oriental fruit fly in Hawaii and of the citrus blackfly in Mexico accounted for pronounced drops in fly numbers in some infested areas.

Several all-time records were established in plant quarantine operations. Foreign air traffic was the heaviest in the history of aviation, imposing an extra work load on an already fully occupied inspection staff. More aircraft than ever before received preflight inspections in Hawaii and Puerto Rico and were cleared for departure for the mainland. Plant material about to move contrary to plant quarantine safeguards was removed from nearly one-third of the planes. For the second consecutive year, inspection of vehicular traffic from Mexico, another important means of entry for foreign pests, exceeded all previous records. A new high was also set by ocean traffic reaching United States ports. Approximately one incoming ship out of four transported prohibited or restricted plant material. The peak demands for the services of plant quarantine inspectors taxed to the utmost the staffs at the many ports of entry.

There were more changes among top Bureau officials than in any past year. Sievert A. Rohwer, for many years assistant chief in charge of regulatory activities, died on February 12, 1951, only a few weeks after he had transferred to the Office of the Agricultural Research Administrator, as special assistant for defense. Erle G. Brewer, in charge of the Division of Japanese Beetle Control, died on October 20, 1950, and William H. White, head of the Division of Truck-Crop and Garden Insect Investigations, on March 14, 1951.

Herbert L. J. Haller was appointed assistant chief in charge of insecticide and chemical problems on March 2, 1951, and Henry G. Herrell became deputy assistant chief for administrative affairs on January 12, 1951.

Some new division leaders were appointed. James A. Beal was made head of the Division of Forest Insect Investigations on August

21, 1950, to succeed Frank C. Craighead, who had retired the preceding May 1. On October 23, 1950, William A. Baker was appointed to head the Division of Cereal and Forage Insect Investigations, to succeed Clyde M. Packard, who had retired the preceding September 30. Paul A. Hoidale, formerly in charge of the Division of Mexican Fruit Fly Control, was transferred to Denver, Colo., on November 1, 1950, to head the Division of Grasshopper Control. He succeeded Claude Wakeland, who for reasons of health had asked to be relieved of administrative responsibilities.

Curtis Clausen, head of the Division of Control Investigations and the Division of Foreign Parasite Introduction, retired on January 31, 1951; Randall Latta is acting in charge of these divisions.

A major reorganization of the Bureau's administrative set-up, begun in May, was ready to operate at the end of the fiscal year. Special studies of headquarters and field organizations were made to determine the best way to coordinate the diverse activities. Regionalization of control and regulatory activities was considered the most feasible move. The initial step in regionalizing the work was taken with the designation of Roy G. Richmond, then head of the Division of Domestic Plant Quarantines, as regional director of the northeastern region, with headquarters at Greenfield, Mass. Subsequently, Wesley G. Bruce, in charge of the Savannah, Ga., laboratory, was appointed director of the southeastern region, with headquarters at Gulfport, Miss., Lev F. Curl, formerly in charge of the Division of Pink Bollworm Control, as director of the southwestern region, with headquarters at San Antonio, Tex., Harry L. Smith, formerly in charge of the Division of Golden Nematode Control, as director of the north central region, with headquarters at Minneapolis, Minn., and Warren V. Benedict, formerly in charge of white pine blister rust control on the west coast, as director of the western region, with headquarters at Berkeley, Calif. Regional administrative officers were also appointed for each region.

The purpose of the reorganization was to provide the best possible utilization of the Bureau's manpower and equipment. It has permitted unification and standardization of many policies and procedures governing program operations. No change was made in the program direction of the Bureau's research activities or of the Division of Grasshopper Control and the Division of Foreign Plant Quarantines, although the field administrative functions of these programs are handled through the five regional offices. The individual regulatory and control activities previously having divisional status, other than the two mentioned, now maintain their identity as projects under the regional plan.

The administrative organization of the Bureau was further strengthened by the establishment, in May 1951, of four new divisions under the general direction of the assistant chief for administration. They are the Administrative Services Division, the Accounting and Auditing Division, the Budget and Administrative Management Division, and the Personnel Management Division.

The Bureau's work on the utilization and adaptation of aircraft and other special equipment for the control of agricultural pests was consolidated. In May 1951, an Aircraft and Special Equipment Center was established at Oklahoma City, Okla., with Kenneth Mes-

senger, a Bureau employee with extensive experience in work of this type, in charge.

Toward the end of the fiscal year contacts were made with State officials with the object of strengthening surveys for destructive insects. The plan being developed contemplates particular emphasis on protection against biological warfare.

Much of the Bureau's research and service work was reviewed by commodity advisory committees, which made numerous helpful suggestions.

COTTON INSECTS

Supercrop of Boll Weevils Causes Huge Cotton Losses

Boll weevils in 1950 reached their greatest destructiveness since the summers of 1921 and 1922. They were even more numerous and caused greater destruction than in 1949, when infestation averaged higher than in any other year after 1927. Losses would have been infinitely greater had not the growers used more insecticides than ever before. Cotton growers applied an estimated 750 million pounds of insecticides in 1950, as compared to 200 million pounds in 1949. Boll weevils caused an estimated 22.6 percent reduction in cotton yield, according to the Bureau of Agricultural Economics.

Boll weevil numbers were at record highs over wide areas in 1950. As a result of a mild winter in 1949–50 the weevils survived in unusually large numbers. In most of the States where the boll weevil was present conditions during the summer of 1950 were favorable for the insect. By the latter part of July serious infestations had been reported in northern Mississippi, Tennessee, northern Arkansas, and southern Missouri, where weevils usually cause little or no damage. In August damaging infestations were reported in southwestern Oklahoma in areas where the weevil had never been known before.

Despite the enormous quantities of insecticides used, boll weevils caused the greatest reduction in yield ever recorded in Arkansas, North Carolina, and Virginia. In Arkansas the reduction was 26 percent, in North Carolina 54 percent, and in Virginia 63 percent.

Insecticides Used in Vast Quantities

Thousands of farmers for the first time used insecticides to control cotton insects. In Texas approximately 200 million pounds of insecticides were used. In Mississippi, with about 2 million acres in cotton, more than 100 million pounds were used. In each of a dozen or more States millions of pounds of insecticides were used for the control of cotton insects in 1950. More insecticides were used early in the season for the control of over-wintering boll weevils, thrips, aphids, and cotton fleahoppers in South Carolina, Mississippi, and Texas than in any previous year. With the exception of a few fields in Texas, all fields given early-season applications of insecticides required late-season applications for the control of the boll weevil.

Another development in 1950 was the use of vast quantities of liquid sprays on cotton. Millions of gallons were applied to several million acres.

972753—52——2

More than a dozen chemicals were used in several dozen formulations. Leading insecticides now used on cotton include calcium arsenate, sulfur, benzene hexachloride, toxaphene, DDT, aldrin, dieldrin, chlordane, parathion, paris green, nicotine, and TEPP. It is estimated that approximately 200 million pounds of sulfur, either alone or mixed with other materials, was dusted on cotton in 1950.

Community-Wide Experiments Increase Quantity and Improve Quality of Cotton

Experiments on the control of cotton insects through early-season application of insecticides on a community-wide basis were conducted in central Texas in 1950. Here the cotton fleahopper and several species of thrips are injurious early in the season. The boll weevil is the most destructive. The bollworm appears later in the season and is the most difficult cotton insect to control.

All the cotton fields on 36 farms in 2 communities near Waco received 3 early-season applications of insecticides for control of cotton insects. More than 3,600 acres were treated on these farms. Comparable untreated farms in two communities were used as checks. The untreated communities comprised approximately 1,000 acres on 17 farms. Sprays were used on 93 percent of the acreage and dusts on 7 percent. Application dates ranged from May 21 to June 15. The early applications gave seasonal control of thrips and fleahoppers. They also gave seasonal control of the boll weevil on 90 percent of the acreage.

There were no mid-season or late-season treatments. Despite omission of the late-season treatments, there was no damage by the bollworm, as would ordinarily be expected. Beneficial insects, which were plentiful in all fields, prevented serious damage in several fields where bollworm infestations were threatening.

Early-season treatment speeded early fruiting to the extent that the treated cotton matured and was harvested 2 to 3 weeks earlier than the untreated cotton. It was possible to destroy most of the cotton stalks by Sepember 30, and nearly all were destroyed by October 15. Protection of the crop from insect damage also resulted in the production of high-grade cotton.

In the two communities the average acre production of lint cotton was 474 pounds from the treated and 270 pounds from the untreated cotton, a gain of 204 pounds of lint cotton an acre. The net profit was $74.84 an acre, or $269,575 on the total acreage.

The new approach to control of cotton insects, with modifications, may have wide application in the Cotton Belt. If so, it will significantly reduce the requirements for insecticides, manpower, and equipment to protect the crop from insect attack.

Many Insecticides Effective Against Boll Weevil

Studies during the year show that the boll weevil may be effectively controlled with benzene hexachloride, calcium arsenate, toxaphene, aldrin, and dieldrin. Benzene hexachloride should be applied at a rate of not less than 0.3 pound of gamma isomer an acre, calcium arsenate at 7 to 10 pounds, toxaphene at 2 to 3 pounds of the technical grade, aldrin at 0.25 to 0.5 pound, and dieldrin at 0.15 to 0.4 pound.

With the exception of calcium arsenate, the materials were about equally effective when applied as concentrated sprays or in dust formulations, when the same amount of toxicant was used. Calcium arsenate was most effective as a dust. When these insecticides are used to control the boll weevil under field conditions, other insect problems must be considered. Infestations of cotton aphid, bollworm, and spider mites may develop when some of the preparations are used alone.

Several other new insecticides have been used effectively against the weevil in some areas. Heptachlor, ethyl *p*-nitrophenyl thiobenzene phosphonate (EPN), and diethoxy thiophosphoric acid ester of 7-hydroxy-4-methyl coumarin (Potosan) have shown promise in experiments and are being extensively tested.

In large-scale experiments in Mississippi, aldrin, benzene hexachloride, chlordane, dieldrin, and toxaphene gave satisfactory control as dusts or sprays. In oil solutions some caused very little injury to the cotton plant. Heptachlor at a 5-percent concentration in dust, or 0.5 pound an acre in spray, gave satisfactory weevil control under field conditions.

In field experiments in South Carolina, mixtures containing DDT and benzene hexachloride, lindane, chlordane, or toxaphene gave excellent control of the boll weevil and prevented damage by the bollworm when applied in either dust or spray form. Aldrin, dieldrin, heptachlor, and toxaphene, applied alone as dusts or sprays, also gave control of the boll weevil.

Control of Thrips Increases Yield of Seed Cotton

Aldrin, dieldrin, and toxaphene at acre dosages of 0.125 and 0.25 pound, 0.0625 pound, and 0.75 and 1.5 pounds, respectively, applied as sprays to young cotton were effective in controlling several species of thrips in experiments conducted near Waco, Tex. Toxaphene and dieldrin gave longer residual control than aldrin. Less effective were tetraethyl pyrophosphate at a dosage of 0.25 pound and aldrin at 0.0625 pound an acre. Increases in yield of cotton from applications of insecticides for control of thrips ranged from 5 to 20 percent. Control of thrips accelerated fruiting and hastened maturity. In one experiment all open cotton was picked late in August. At that time the cotton treated for thrip control yielded 1,558 pounds and the adjoining untreated cotton 762 pounds of seed cotton an acre. Another picking early in October brought the total yield of the treated cotton to 1,750 pounds of seed cotton an acre, as compared with 1,500 pounds in the untreated cotton, or a gain of 250 pounds an acre.

Bollworms Checked by Control Measures Against Boll Weevil

Damage to the cotton crop from bollworms again was comparatively light in 1950, although serious outbreaks were reported late in the season, especially in Arizona, Texas, Oklahoma, and Louisiana. The heavy spraying and dusting schedule for controlling the boll weevil in July and early August apparently held the bollworm in check in most areas.

On May 2 threatening bollworm infestations were reported in the Rio Grande Valley of Texas, but serious infestations did not develop

there. Late in June infestations of lepidopterous larvae, principally the bollworm and the tobacco budworm, were reported in many areas in Mississippi. By the latter part of the month light infestations had been reported from most of the cotton-growing States. Reports of light infestations of lepidopterous larvae were received from most States in July. By the third week of August infestations requiring control were reported from many parts of Louisiana, Texas, Oklahoma, and Arizona. Because of a critical shortage of DDT and toxaphene, losses due to bollworms were serious in some areas in these States, especially in Oklahoma.

In experiments near Waco, Tex., toxaphene dust gave better control of the bollworm than toxaphene spray. Dieldrin applied at a dosage effective for the boll weevil did not give satisfactory control of bollworms. A mixture of aldrin and DDT applied by airplane as a spray, at a rate of 0.375 pound of aldrin and 0.375 pound of DDT an acre, controlled a heavy infestation of bollworms in a large-scale experiment in north Texas, where rains were frequent and insects plentiful. The control of the bollworm with this small quantity of DDT was attributed to the fact that the treatments were started as the infestation developed and were continued at regular intervals throughout the infestation period.

Causes of Seasonal Decline in Effectiveness of Insecticides Studied

Field cage tests over a 3-year period at College Station, Tex., showed the effect of the advancing season on the effectiveness of several insecticides against the boll weevil. Toxaphene, technical benzene hexachloride, aldrin, and dieldrin were only about one-half as effective in September and October as in June and July, and calcium arsenate was approximately two-thirds as effective. Up to four times the normal dosage of these insecticides did not increase late-season mortality. Extremely high dosages were required to effect in September and October a kill equal to that obtained in June and July. In one season's tests, EPN did not show the reduction in effectiveness shown by the chlorinated hydrocarbon insecticides and calcium arsenate. Phosphorus insecticides evidently differ from the other insecticides in the way they affect the boll weevil.

Biochemical investigations showed that the fat content of the boll weevil greatly increased as the season advanced, ranging from an average of 4.9 percent on a dry-weight basis in overwintered weevils in June to 22.9 percent in field-collected weevils in October. When correlated with toxicity data, these results indicate a highly significant negative relationship between the fat content of the boll weevil and the effectiveness of certain chlorinated hydrocarbon insecticides, a relationship not evident with EPN.

This research was conducted with funds authorized under the Research and Marketing Act.

Bureau Sponsors Conference on Cotton Insects

The yearly conference to pool the results of experiments on the control of cotton insects was of wider scope than in previous years. Participating in the fourth conference, held at Memphis, Tenn., in December 1950, were 76 entomologists and associated technical work-

ers from 12 cotton-growing States, Puerto Rico, and the Bureau. The conference report was used in preparing recommendations for the control of cotton insects in the various States. Although designed primarily for the cotton-growing areas of the eastern half of the United States, the conference reports have been translated into French, Portuguese, and Spanish for distribution in other cotton-growing countries.

Cotton Leafworm Extends Its Range

The cotton leafworm was extremely abundant in 1950 and caused serious losses in many areas where spraying was inadequate. It reached Texas earlier than it had since 1943 and also spread more rapidly and over a larger area. Before frost checked its spread, it had reached all cotton-growing States except California.

By the end of June leafworms were reported in 37 counties in Texas, in 1 county in Oklahoma, and in Madison Parish, Louisiana. By the latter part of July they had spread to Arizona, Arkansas, and Mississippi; in August they reached Missouri; and in September light infestations were reported in Alabama, Florida, Georgia, the Carolinas, and Tennessee. Heavy applications of insecticides for the control of boll weevils in Arkansas, Mississippi, Louisiana, Texas, and Oklahoma apparently delayed leafworm outbreaks in many areas. A critical shortage of insecticides in August and September kept many farmers from controlling the leafworms, with resulting damage by the worms, especially in Missouri, northern Arkansas, northern Texas, and Oklahoma. Through the efforts of Federal, State, and extension entomologists and the insecticide industry, supplies of insecticides were diverted to areas where leafworms were doing the most damage.

Insecticides applied as sprays gave excellent control of cotton leafworms in experiments near Waco, Tex. Parathion, at dosages of 0.125, 0.25, and 0.375 pound an acre, gave the most effective control and quickest kill of the insecticides tested. It gave complete control of a heavy infestation of leafworms within 17 hours. Toxaphene at 1.5 pounds an acre gave satisfactory control within 24 hours. Aldrin and dieldrin gave good control of small worms of early broods, but failed to kill large worms of late broods. The two insecticides, when applied at 4- or 5-day intervals against the boll weevil, checked developing leafworm infestations, but did not give a sufficiently quick kill of large leafworms to save crops from being attacked.

DDT Still Outstanding for Control of Pink Bollworm

DDT continued to give better control of the pink bollworm than any of the other insecticides tested. Cage tests showed that DDT not only reduced the number of eggs laid by the moths but also killed a high percentage of first-instar larvae. In a test to determine the correct interval between applications, 2 pounds of DDT an acre applied at 8-day intervals gave about the same degree of control as 1 pound of DDT an acre applied at 4-day intervals. Where pink bollworms and boll weevils infested the same field, DDT mixed with benzene hexachloride, aldrin, dieldrin, toxaphene, or low-lime calcium arsenate, plus parathion or benzene hexachloride, gave satisfactory control of both insects.

Observations show that when cotton stalks are cut in extremely hot, dry weather a high percentage of the pink bollworm larvae in bolls exposed on the soil surface are killed by the heat.

Hibernation experiments conducted over a 3-year period at Big Spring in the South Plains area of Texas showed that the pink bollworm survives the winter there.

Pink Bollworm Quarantine and Control Continued

Late stalk destruction causes widespread infestations

Destruction of cotton stalks for cultural control of the pink bollworm did not meet the deadlines set in much of south Texas in the fall of 1949, largely because of weather favorable for a top crop but unfavorable for stalk destruction. As a result, cotton in a number of fields fruited late, some in Nueces County not until November. During the spring of 1950 more than 75 percent of the fields examined in Nueces County had infested blooms. The early infestations allowed heavy build-up of pink bollworms in many fields, resulting in the heaviest infestation on record in this county. Very early in the crop season infestations from the fields spread by flight or wind carriage of the moth to other parts of the infested area in south Texas. Further outward spread continued by natural flight into known infested areas and into previously uninfested counties.

The heavy increases in infestation and the new outbreaks aroused cotton growers in south Texas to the need for stalk destruction by the State-imposed deadlines. Stalks in the Lower Rio Grande Valley were destroyed by the August 31 deadline. Fortunately, the more heavily infested fields in Nueces County were cleared of stalks fully 3 weeks ahead of the September 25 deadline. It was more difficult to obtain compliance with the September 25 deadline in several other counties having dry-land areas in which a late crop of cotton had been planted. In counties with an October 15 deadline compliance was more nearly complete than in any other year since the requirements went into effect.

Record infestations found in 1950 cotton crop

Inspections in the regulated parts of Arizona, New Mexico, Oklahoma, and Texas showed only 23 counties free from pink bollworm; 64 were uninfested in 1949. In addition to the infestation in Nueces County, Tex., there were increases in the infestations along the northern and eastern boundaries of the south Texas regulated area. Infestation was also heavier in central-west Texas and the South Plains section of the State. The Pecos Valley had a heavy build-up of pink bollworms and Presidio County suffered severe damage from them. The infestation in the El Paso Valley, however, was lighter.

Infestations were again found in Oklahoma. In New Mexico light infestations recurred in most of the cotton-growing counties. Arizona was free of the pink bollworm for the second consecutive year. Infestations were found for the first time in 35 counties in Texas, 3 counties in Oklahoma, and 4 parishes in Louisiana. Eight of the newly infested Texas counties are primarily devoted to ranching and grow little cotton. The other 27 Texas counties extend from the Gulf of Mexico to the Oklahoma boundary, forming an approximately

2-county-wide tier along the eastern perimeter of the 1949 regulated area. The infestation in Louisiana marked the third appearance of the pink bollworm in the State. Following eradication of the second infestation there, the quarantine had been removed in 1946. In Florida there was a marked decrease in the infestation of wild cotton from that found shortly after the eradication of wild cotton was resumed there in 1949 after a 2-year interval.

The 1950 cotton crop was inspected for pink bollworms within all regulated areas, as well as in Alabama, Arkansas, California, Georgia, Louisiana, Mississippi, Oklahoma, the nonregulated sections of Arizona and Texas, and the domestic cotton-growing area of Florida. Similar inspections were made in Sonora and Sinaloa, on the west coast of Mexico.

Noncotton zones established in Louisiana

A clean-up program for cotton fields was inaugurated in Louisiana immediately following the finding of pink bollworms there. November 15 was set as a mandatory deadline for the destruction of cotton stalks. A few fields in Cameron Parish showed an almost 100-percent infestation in green bolls late in the season, with as many as 15 pink bollworms to the boll in some fields. Farmers were informed of the infestation by radio and through meetings called in the various communities. An estimated 99 percent of the infested fields were cleaned up on time. A State order designated Cameron Parish and parts of Calcasieu and Vermilion Parishes as zones in which cotton was not to be grown in 1951. The acreage taken out of cotton in the three parishes amounted to approximately 1,200 acres.

Control by insecticides demonstrated to growers

A spraying program was demonstrated in Maverick County, Tex., early in the crop season. A DDT-toxaphene spray was applied to control the insects that delayed early setting of the crop, thereby getting a quicker maturity of the cotton and earlier destruction of the stalks.

A mixture of benzene hexachloride, DDT, and sulfur was applied as a dust to cotton on about 1,200 acres in the Pawnee section of Bee and Karnes Counties, Tex. This acreage was fairly heavily infested; it could have been the source of a spread of the infestation to areas free of the pest.

Quarantine procedures modified

Changes were made in the authorized methods of treatment as a condition for the interstate movement of cottonseed. The counties of Curry and Quay in New Mexico were added to the lightly infested area from which cottonseed might be shipped after fumigation. A new method of fumigating bulk cottonseed in railway cars or trucking vans was approved as a second treatment preliminary to certification for movement from the heavily infested area. These changes were effective July 19, 1950.

The State of Louisiana was included in the quarantined area on May 29, 1951, and the lightly infested area was extended to include 12 parishes of that State, along with 1 county in New Mexico, 4 counties in Oklahoma, and 44 counties in Texas. Samples of cotton lint

and linters of 1½ pounds were conditionally released from the certification requirements.

Quarantine-enforcement activities about normal

More than 3 million bales of cotton was ginned at the 1,700 gins operating under supervision of pink bollworm inspectors. Nearly 500 such gins are equipped with cottonseed heaters to kill pink bollworms as a continuous process of ginning. In addition, 43 oil mills are authorized to treat seeds produced at some 750 other gins. More than 1 million tons of cottonseed was treated at gins or oil mills having approved heat-sterilization or fumigation equipment.

Inspectors at two highway inspection stations on the border of the regulated area in the Lower Rio Grande Valley inspected 76,000 vehicles and intercepted 2,800 lots of cotton or cotton products likely to harbor pink bollworms.

Control activities in Mexico parallel those in United States

Stalk destruction in 1950 was carried out as effectively in adjacent areas of Mexico as across the border. Individual cotton-planting permits were issued to 23,000 growers in the Matamoros region covering an estimated 800,000 acres. August 31 was set as the mandatory deadline for stalk destruction, the same as that in effect for adjacent areas in this country. Well over 99 percent of the stalks in the Matamoros region were destroyed by the end of August.

Under authority of a Presidential decree, there is being organized in each agricultural region an official agency to be known as the Patronato de Investigacion, Fomento y Defensa Agricola. These agencies will replace the regional agricultural committees.

Advances in the use of insecticides as a supplement to control by cultural practices continued in the Laguna area of Mexico. More cotton growers made early applications of insecticides to control the insects that appear first, thus getting a good crop set before pink bollworms built up to damaging numbers.

Eradication of wild cotton lessens threat to Cotton Belt

Nearly 37,000 acres were surveyed in the southern Florida coastal areas and 111,500 wild cotton plants were removed during the year. Only 220 pink bollworms were recovered from 42,400 squares, blooms, and bolls examined, or an average infestation of 0.5 percent. This was a drastic reduction from the heavy infestation found in January 1950, when there was an average of 42 percent in some sections. Inspections north of Everglades City showed that there is a wide area between the infested wild-cotton areas and the portion of Florida where cotton is grown as an annual crop. The immediate threat of spread of the pink bollworm from this coastal area to domestic cotton-producing areas in Alabama and Georgia has been averted.

FOREST INSECTS

All-Out War Waged Against Engelmann Spruce Beetle in Colorado

The most extensive campaign on record to control an outbreak of tree-killing beetles was initiated in the Engelmann spruce forests

of Colorado. Some 784,000 trees on 33,000 acres were individually sprayed by Forest Service crews working under the technical direction of forest entomologists. Despite these efforts, about 1,500,000 new trees were infested. These will require treatment in 1951 if the outbreak is to be kept within its present limits. Flight of beetles to new trees in 1951 will be greatly reduced as a result of the work in 1950.

Observations in the infested areas showed that woodpeckers ate nearly all the beetles on trees in some outbreak centers, as well as beetles in trees in outlying localities. Three species of woodpeckers—the Alpine three-toed, the Rocky Mountain hairy, and the downy—were particularly effective in consuming bark beetles.

The Engelmann spruce beetle has already killed more than 4½ billion board feet of valuable timber. It is a threat to the remaining spruce stands of Colorado, northern New Mexico, and southern Wyoming.

DDT Spray From Helicopter Controls White Pine Weevil

Application from a helicopter of 2 pounds of DDT in 2 gallons of oil an acre to 225 acres of white-pine and Norway-spruce plantations in the Northeast in April 1950 resulted in excellent control of the white pine weevil. Previous attempts to control the insect by applying DDT from fixed-wing aircraft had been unsuccessful. Studies are being continued to determine the lasting effects of the insecticide and the period during which spray operations can be conducted successfully.

DDT Spray From Helicopter Controls Pine Reproduction Weevil

Excellent control of the pine reproduction weevil was obtained by spraying pines in brushfield plantings with DDT from a helicopter. In cooperation with the Forest Service 606 acres of plantings in three areas on the Lassen and Eldorado National Forests in California were sprayed. More than 90 percent of the weevils were killed and tree losses from weevil activity were reduced by about 95 percent. The average acre cost was $2 for the helicopter and 87 cents for other items.

Cheaper and More Effective Methods Developed for Airplane-Spray Experiments

New apparatus, for installation in an airplane, that simultaneously disperses two separate sprays has greatly simplified the testing of aerial-spray equipment. In previous experimental work separate flights had been necessary for testing different equipment or different adjustments of equipment parts. This was not only expensive and time-consuming, it was unsatisfactory because no two flights could be made under identical weather conditions. It was known that variations in these conditions often affected spray deposits. To obtain valid results, therefore, it was necessary to study statistical data from a great many flights. With the new apparatus equally valid results may be obtained with one-tenth as many flights.

972753—52——3

Benzene Hexachloride Widely Accepted by Lumber Industry for Control of Ambrosia Beetles

The lumber industry is using more and more widely benzene hexachloride sprays developed in Mississippi and tested in the Gulf States for the protection of logs and lumber from attack by ambrosia beetles. The increased use of these sprays coincides with a greater need for their protective qualities. Timber values are increasing and stock piling of logs is being more generally practiced. This leads to increased danger from uncontrolled ambrosia beetle activity. Use of the sprays has also been extended to the Tropics, where the beetles are particularly troublesome. Requests for information on the subject have been received from many parts of the world.

Ethylene Dibromide Simplifies Fight Against Bark Beetles

Development of a water emulsion of ethylene dibromide has eliminated the necessity for transporting into the forest large quantities of fuel oil to be used in sprays to control Black Hills beetles infesting pines in the Rocky Mountain area. Ethylene dibromide in oil solution is effective against the Engelmann spruce beetle and several other bark beetles.

Weevil-Resistant Pine Hybrids Developed

Several pine hybrids developed by the Forest Service's Institute of Forest Genetics at Placerville, Calif., have been tested for resistance to the pine reproduction weevil. The most outstanding resistant hybrid yet produced is a backcross obtained by pollinating Jeffrey pine cones with the pollen of a natural hybrid of Coulter and Jeffrey pines. This hybrid retains the desirable silvicultural characters and wood qualities of its Jeffrey parent, a species highly susceptible to the weevil, and the resistant qualities of its Coulter parent, a species not injured by the weevil.

Cooperative studies with the Institute of Forest Genetics showed that the immunity of Coulter pine to weevil injury may be attributed to failure of the weevil to tolerate the turpentines of this species. The same turpentines are present in the Jeffrey-Coulter hybrid, thereby rendering it resistant.

Turpentine Beetles Become Vicious Tree Killers

After long being considered of secondary importance, the black turpentine beetle in the South and the red turpentine beetle in the Cleveland National Forest in California have developed almost simultaneously into primary tree killers. Until 2 or 3 years ago the black turpentine beetle was known to breed largely in pine stumps in the Deep South. Although it attacked standing trees, it rarely caused their death. Recently, reports have been received from many parts of the infested area telling of tree killing by this species in stands following cutting operations and in turpentine orchards. Shade trees and isolated countryside trees have also been destroyed. In California the red turpentine beetle was found attacking the underground portions of the main trunk and larger roots of living Jeffrey

pine trees, thus causing injuries that weakened the trees and hastened their death.

Studies are under way to determine the most effective and economical measures to control these beetles. No method of controlling the red turpentine beetle is known at present.

Southern Pine Beetle Breaks Out in South

For the first time in about 20 years the southern pine beetle killed pines on a widespread scale in the South. Injury was especially severe in eastern Texas, where an estimated 100 million board feet of timber in an area of 180,000 acres was killed by the end of 1950. There were other scattered outbreaks, on a smaller scale, throughout the South, especially in Alabama and North Carolina. Land-managing agencies were offered advice on how to control the outbreaks, largely by the prompt removal of infested trees and destruction of bark beetle broods.

Tests were conducted to determine the value of new insecticides in controlling the beetle. Results indicated that benzene hexachloride may surpass orthodichlorobenzene, long considered the standard insecticide for control of bark beetles.

Observations in Texas indicate that present knowledge of the habits and activities of this insect, largely gathered from studies made years ago in more northerly and easterly parts of the South, is inadequate to explain the conditions now existing in the Deep South.

Entomologists Assist in Salvaging Wind-Thrown Timber

In November 1949 hundreds of millions of board feet of coniferous sawlog timber and poles were felled by southwest winds blowing across northern Idaho and western Montana. The volume of the material was so great that several years will be required to salvage it, using the entire region's available logging and milling facilities. The felled timber was exposed to unusual attacks by bark beetles and wood borers. After an investigation, Bureau entomologists recommended immediate salvage of timber in imminent danger of insect attack. Salvage operations were therefore directed into areas of greatest danger. It is anticipated that most of the wind-thrown timber will be logged before serious insect infestation develops.

Survey on European Pine Shoot Moth Aids in Selection of Planting Sites for Red Pine

Surveys conducted cooperatively with the New York State Department of Conservation show that the European pine shoot moth is not a serious pest of red pine in sections of New York where the average minimum winter temperature is −10° F. or lower. In contrast, severe infestations were found in warmer areas. This finding on temperature effects on the insect agrees with the results of previous investigations which showed that heavy mortality of overwintering shoot moth larvae results from the low temperatures. Foresters in New York may now select areas where red pine can be planted without fear of severe damage by this insect.

Control Campaigns Against Gypsy and Brown-Tail Moths Continued

Control operations wipe out source of bait lure

Attesting to the effectiveness of the extensive 1949 and 1950 control operations was the necessity for abandoning in 1950 the large-scale collection of female gypsy moth pupae. Collections in previous years reached as many as a million pupae from which to rear female moths, which, in turn, yield the attractant used in the thousands of traps set to detect outlying infestations. Barnstable and Plymouth Counties in southeastern Massachusetts have usually yielded all the pupae needed in trapping activities. Spraying these counties in their entirety and intensive spraying in many other sections within the generally infested area eliminated these as collecting grounds. Collections were attempted in a few towns in Norfolk County, where gypsy moth numbers had been high. It was soon found that parasites and the wilt disease had so reduced the numbers that further collections there were uneconomical. This led to a decision to transfer attractant operations to Europe.

An entomologist, detailed in the spring of 1951 to look for heavy moth infestations in Portugal, Spain, France, and Italy, found extensive areas of heavy infestation near Lisbon, Portugal. About 472,000 pupae were collected. Approximately 170,000 tips containing attractant were clipped from the female moths that emerged from the pupae and shipped to this country for processing into bait material.

Large-scale trapping and spraying continued

More than 19,600 traps were used during the summer of 1950 in cooperative Federal-State surveys covering 7,190,000 acres in 812 towns or townships in Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Trapping and scouting gave negative results in both New Jersey and Pennsylvania. No gypsy moth infestation has been found in New Jersey since 1935 or in Pennsylvania since 1949. Results of the trapping in New England and New York furnished the basis for further scouting or spraying there. Trap captures in New York showed no westward spread of the moth. In fact, they showed substantial progress toward elimination of all general infestations west of the Hudson River.

Trap captures and supplementary scouting showed that the moth is more abundant in western Connecticut and Vermont than for several years.

Nearly 180,000 acres were sprayed with DDT in Connecticut, Massachusetts, New York, and Vermont. Approximately 178,000 acres were sprayed by aircraft; the remainder by mist blowers. The last sizeable area of general infestation west of the Hudson River—in Saratoga County—was sprayed when more than 120,000 acres were covered in New York. Other aerial spraying in New York was limited principally to areas west of the Hudson River where aerial spraying in past years had eliminated general infestation. Aerial spraying in western Connecticut and Vermont minimized the hazard of newly hatched caterpillars being spread by the wind into adjacent areas of New York and prevented further build-up in heavily infested areas. In Massachusetts, the entire island of Nantucket, comprising 31,000

acres, was sprayed by aircraft to eradicate the moth there and incidentally keep wind-borne larvae from reinfesting nearby Barnstable County.

Defoliated acreage lowest in 25 years

Field observations by Federal and cooperating State agencies showed a total of only 5,400 acres defoliated by the gypsy moth in the summer of 1950—the lowest reported since 1924, when only 825 acres were defoliated. Extensive use of aircraft and mist blowers in spraying areas of heaviest population was the most important factor in the reduction. Parasites, predators, and wilt disease, along with a heavy mortality of newly hatched larvae as a result of a cold, wet period in May 1950, also contributed to the reduction. The winter of 1950–51 was mild and otherwise favorable for gypsy moth survival.

Simplified certification procedures approved by shippers

Various means were used to simplify compliance with the requirements of the gypsy moth quarantine by producers and shippers. Growers applied DDT to 460 acres in and around nurseries to assure noninfested stock. Some 22,700 cords of pulpwood and fuel wood were moved under limited permits on the basis of immediate consumption of the wood at destination. Upon determination that conditions at either producing or processing sites would insure against the spread or establishment of the moth, 590 establishments were authorized to operate under certification agreements. Advance scouting showed 50,000 acres of lumber and pulpwood areas to be free from infestation. Products from this acreage were eligible for certification when cut. State agencies and shippers cooperated in the fumigation with methyl bromide of 266,000 Christmas trees. More than 450 tourist camps, scrap-metal yards, and gas-cylinder establishments were scouted. The owners of 51 such establishments destroyed moth infestations on their properties.

Quantities of products certified for movement from eastern New York and New England to markets and consumers throughout the United States and Canada greatly exceeded those of the previous year. Products certified during the fiscal year included 301 million board feet of lumber, 400,000 logs and poles, 75,500 cords of pulpwood and fuel wood, and 220,000 bales of excelsior and shavings. Nearly 37 million nursery and field-grown plants, 420,000 Christmas trees, and 93,000 bundles of evergreen boughs were certified as free of the gypsy moth and shipped to nonregulated areas. Certified quarry products included 335,000 tons of stone and granite and 338,000 pieces of monument materials. Articles certified had an estimated value of $54,000,000.

Inspectors stationed near the boundaries of the regulated area in periods of heavy movement of regulated products prevented the transportation to noninfested points of 145 shipments of uncertified products.

Heat take-off from automobile speeds fumigation

Methyl-bromide fumigation of refrigerator cars as a condition for gypsy moth certification was expedited and greatly simplified by the development of a hot-water volatilizer for the gas. The vol-

atilizer is heated by hot water circulated from an automobile radiator. Electrically heated volatilizers were previously used. When the loaded boxcars to be fumigated were on sidings far from sources of electricity gypsy moth inspectors were obliged to use portable electric generators.

Brown-tail moth at low ebb

Spraying for gypsy moth control in southeastern Massachusetts has apparently eliminated the brown-tail moth that persisted for many years on beach plums and other vegetation there. This insect continued at a very low ebb throughout its known area of infestation in eastern New England. The heaviest known center of infestation was discovered late in May 1950 in the town of Bradford, Merrimack County, N. H., where 20 acres of open country containing several abandoned apple orchards was heavily infested. A mist blower was used to spray readily accessible parts of the infestation.

CEREAL AND FORAGE INSECTS

Control Campaign Against Grasshoppers Continued

Upswing in grasshopper numbers requires continued control programs

Grasshopper numbers increased sharply in 1950, both in croplands and on ranges, in the western half of North Dakota, southwestern South Dakota, north-central Montana, northeastern Colorado, western Nebraska, and the Oklahoma Panhandle. They decreased in Texas, Minnesota, Washington, and parts of several other States.

The Bureau again cooperated with State, county, and other Federal agencies and landowners in 24 Western and Midwestern States in control programs. Grasshopper control in 1950 was of two distinct types—the protection of cultivated crops through spraying, dusting, and baiting operations, and the reduction of large-scale range infestations on private range and Federal domain by baiting and spraying.

New insecticides stimulate farmer participation

Probably more farmers practiced grasshopper control in cultivated croplands in 1950 than in any previous year. Ready availability to landowners of organic insecticides greatly influenced the control work individually undertaken. Farmers bought and applied at their own expense large quantities of aldrin, benzene hexachloride, chlordane, and toxaphene. These materials, as sprays and dusts, were used even more widely than in 1949. It is estimated that approximately 5 million acres of crop, pasture, and range lands were treated with these organic insecticides in 1950.

Aldrin, available in quantity in many areas for the first time, was used in various formulations in several large-scale programs. It showed promise of reducing further the acre cost of controlling grasshoppers and simplifying control procedures. Two ounces of aldrin applied in a gallon of oil, or oil emulsion, to an acre gave almost complete control of both crop and range grasshoppers.

Crop baiting drops off as spraying eases control

The 1950 crop-baiting program was much less extensive than in previous years, because organic insecticides have largely supplanted bait. No further purchases of bait material were made from Federal funds. Supplies on inventory in Federal and county storage were furnished to farmers, transportation costs of the bran and sodium fluosilicate in intercounty or interstate movements being borne by the receiving county. Several counties bought supplies of bran, orange pulp, sawdust, and sodium fluosilicate or other toxicants, either for supplementing Federal materials or to furnish their own mixed bait to farmers. In all, 7,600 farmers and ranchers in 206 counties spread 4,173 tons (dry weight) of bait on 643,000 acres of crop and pasture lands. Baiting gave protection to more than 2,860,000 acres of crop and pasture lands. Savings were estimated at $25,328,000, or approximately $36 for each dollar spent. Despite all cooperative efforts, conservative estimates showed that grasshoppers had destroyed $19,333,000 worth of crops. Native grasslands were extensively damaged in several Western States.

Record acreage of range lands treated

Two and three-quarter million acres were baited or sprayed to combat damaging range infestations in Arizona, California, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, and Wyoming. The Bureau cooperated with other agencies in the extensive program. Treated areas included 2,591,000 acres of private range, 148,000 acres of Federal domain, and 10,000 acres of State-owned lands. Bureau aircraft, including a DC–3, two White Standards, and an N3N, baited 211,500 acres. Contract aircraft baited 2,459,000 acres and Bureau ground equipment baited 25,000 acres. In addition, Bureau and contract airplanes sprayed 53,000 acres. Materials used in the range programs varied with the individual States. A total of 12,739 tons of bran-chlordane, bran-toxaphene, bran-orange pulp-chlordane oil baits, and bran-sawdust-sodium fluosilicate bait was used in baiting operations in all 10 States. Approximately 56,000 gallons of aldrin and toxaphene oil solution sprays were used in three States. Cost to all cooperating agencies for the 1950 range-control programs in the 10 States was $1,583,000.

Aldrin recommended for grasshopper control

Extensive tests in Arizona and Montana in 1950 definitely established the value of aldrin, in sprays, dusts, or baits, as an insecticide to control grasshoppers. In some large-scale airplane-spraying tests with aldrin 95 percent of the grasshoppers were dead 3 days after the application. High kills were common also with ground treatments. No adverse effects on livestock, game animals, or birds were observed in any of the areas sprayed with aldrin. As a result of the research, aldrin was included with chlordane and toxaphene in the insecticides recommended for grasshopper control in 1951. Aldrin is effective as a spray at the rate of 2 ounces in 1 gallon of fuel oil an acre or in dust mixtures at 3 ounces of the technical material an acre. It is also satisfactory in poison baits.

Although intensive airplane baiting for 2 years in Wyoming had practically eliminated bait-eating range grasshoppers as an economic factor over extensive areas, there still remained in 1950 from 2,750,000 to 3,000,000 acres of heavily infested private range lands. To reduce infestations to noneconomic importance a large-scale cooperative program was set up. The Wyoming Legislature, at a special session in the spring of 1950, provided $750,000 for the work, which sum was to be matched by the Federal Government. In this cooperative work approximately 2,462,000 acres of range lands were baited by airplane in 16 Wyoming counties at an average cost of 57 cents an acre. Two Bureau and 41 contract aircraft operated from 62 airstrips and airports. All but 10 of the landing fields were specially built by counties and ranchers. The baiting operations saved large quantities of forage. So far as known, no grasshopper migrations originated from treated areas. Grasshopper numbers were greatly reduced in heavily infested areas. At the close of the 1950 season there still remained more than 800,000 infested acres, principally with bait-resistant species.

Arizona and Federal funds in equal amounts were spent to treat about 45,000 acres of a threatening infestation in southeastern Arizona range lands. Because of the high proportion of a bait-resistant species, the work was done by aerial application of an aldrin-oil solution spray at the rate of 2 ounces of aldrin in enough kerosene to make 1 gallon an acre. Seven contract airplanes sprayed slightly more than 43,000 acres, at an average cost of 77 cents an acre.

Farm crops within an area can be protected from grasshoppers by a well-planned program of air or ground spraying with aldrin, chlordane, or toxaphene. To be effective, the program must provide for treatment throughout the season of all sources of infestation within the area to be protected. In 1950 infestations were virtually eradicated on 1,100 acres of small grains and flax in Bottineau County, N. Dak., by spray applications of aldrin and chlordane. Previous work in South Dakota and Nebraska had shown that grasshopper infestations in alfalfa and adjacent fields, field margins, and waste areas in a solid block of farm land could be reduced 90 to 100 percent in a single season by the use of toxaphene or chlordane sprays. The reduction persisted for at least 2 years. It is believed that only limited insecticide treatments of small local infestations within the originally treated area will be necessary for some time to maintain adequate crop protection. It is likely that this method of grasshopper control will be used increasingly by farmers.

Severe infestations expected in 1951

Adult-grasshopper surveys were conducted in 889 counties in 22 States; egg surveys were made in 637 counties in 14 States. The 1950 late-summer and fall surveys indicated that with normal weather in 1951, grasshopper infestations could be expected to be severe and damaging to both crops and range-land forage in many sections of the western half of the United States, despite the extensive control work done in 1950. Range-land infestations again constituted the major threat in several States. In Wyoming the infested area was further reduced by the 1950 program, but there were still threatening infestations on range land. Threatening to very severe infestations are ex-

pected in several areas of Montana, especially the north-central region, and in western North Dakota. Serious and widespread outbreaks are anticipated for southwestern South Dakota, northwestern Nebraska, northeastern Colorado, southern and northeastern California, southeastern Oregon, and northwestern Nevada. Troublesome infestations in 1951 are forecast for scattered areas of Idaho, Arizona, Minnesota, New Mexico, Utah, Kansas, Oklahoma, and Texas.

Mormon Crickets Controlled

Widespread infestations of Mormon crickets did not develop in the Western States, although conditions were favorable for cricket increase and spread, as shown by a noticeable build-up in several counties of Montana, Utah, South Dakota, and Wyoming. Mormon crickets displayed a banding tendency and a distribution pattern similar to that in the late 1930's, when the insect reached major outbreak proportions.

Early baiting operations on ranges in Colorado, Montana, Nevada, Oregon, Utah, and Washington were adequate to protect crops and range forage, resulting in only slight damage by the Mormon cricket. This work was done in cooperation with other Federal agencies, States, counties, and landowners. Most of the baiting was done on the Federal domain. More than 68,000 acres of range lands were baited—43,500 acres by airplane, 24,800 by ground equipment, and 120 by hand. Two hundred and forty-five tons of bait was spread in the operations. Owing to early and adequate work by the cooperators, damage to crops and range forage was slight in 1950.

Late-summer surveys in 1950 indicated that infestations needing control in 1951 would probably develop in several parts of Utah, Nevada, Oregon, and Washington.

Better Protection From Insects Provided for Stored Grain

Insectproofing of bags received further study in cooperation with the Bureau of Agricultural and Industrial Chemistry. Cotton bags and 14-ounce burlap bags treated with a mixture of pyrethrins and piperonyl butoxide have given protection from insect penetration for 14 months. It is now necessary to find some means of binding the insect repellent to the bag fabrics so that flour or other products packed in the treated bags will not become contaminated. Fiberboard cartons sealed with an adhesive containing a mixture of the same chemicals have repelled insects for as long as 9 months.

Tests have demonstrated that fogging with an insecticide may have a definite place in a program of flour-mill insect control and also may be an effective method of destroying insect infestations in railway boxcars. In the fogging of mills large numbers of insects were killed but the insecticide did not reach those that were hidden in the flour stock.

The tests were conducted under Research and Marketing Act funds.

A new fumigant mixture of 1 part of bromotrichloromethane and 19 parts of carbon tetrachloride, used at the rate of 1.5 gallons to 1,000 bushels of wheat in steel farm bins and at 2 gallons in wooden bins, gave 100- and 89-percent kills, respectively, of adult grain in-

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sects. At a dosage of 2.8 gallons to 1,000 bushels, it was also highly effective against immature stages of the rice weevil. This fumigant compared favorably with the standard 80:20 carbon tetrachloride-carbon disulfide mixture applied in the same dosages.

Insecticides Control Sugarcane Borer on Large Scale

In expectation of a severe infestation by the sugarcane borer in the spring of 1950, the Louisiana State Legislature appropriated $250,000 to assist growers in buying insecticides. Bureau entomologists cooperated with Louisiana State entomologists in the program by certifying about 16,000 acres of sugarcane as sufficiently infested to warrant treatment. Altogether, about 62,000 acres in Louisiana were dusted with cryolite or 40-percent ryania.

Among several insecticides tested against the sugarcane borer, a spray of toxaphene at the rate of 2 pounds an acre gave the best control—an average of 97 percent—although several others were almost as good. In general, a 40-percent ryania dust gave better control of the borer than a 7.5- or 15-percent dust plus 0.5 percent of either *n*-propyl isome or piperonyl cyclonene as a synergist. Dusts and sprays of 40-percent ryania were generally more effective than those of cryolite against the sugarcane borer in Florida.

Insecticides Control Legume Insects

Recommendations have recently been published for the control of several important insect pests of legume crops being grown for seed. In Utah lygus bug nymphs and adults and alfalfa weevil larvae on seed alfalfa in bud are destroyed with 20 pounds of 10-percent DDT dust an acre or with a spray containing 1.5 pounds of actual DDT an acre. If a reinfestation of the lygus bugs warrants a second treatment when the alfalfa is in bloom, 20 pounds of 10-percent toxaphene dust an acre or 1.5 pounds of actual toxaphene an acre as a spray should be applied in the early morning or in the evening, when bees are not active in the field. To control adults of the alfalfa weevil in the spring, when the first crop shoots are 1 to 2 inches tall, the application of a water-emulsion spray of chlordane at the rate of 1.5 pounds of chlordane an acre is recommended.

In Arizona dusts and sprays of toxaphene have been used to control lygus bugs on seed alfala in the prebloom stage. Ninety-six percent of the lygus bugs were killed in one 80-acre field with an airplane application of the dust. Reductions of 95 to 98 percent of the bugs were obtained in six 80-acre fields treated by airplane with an emulsion spray of toxaphene.

The clover seed weevil in fields of alsike and white clover in the Willamette Valley of Oregon was controlled with a 5-percent DDT dust applied at the rate of 20 pounds an acre.

Excellent control of the potato leafhopper on alfalfa was obtained in Maryland by spraying with one-half pound of methoxychlor an acre. The crop thus treated showed exceptional growth and quality in comparison with the untreated crop, which was severely damaged by the insect. Methoxychlor also gave good control of the meadow spittlebug in one small test.

Several of the new insecticides appear promising in the control of the corn rootworm on peanuts. In preliminary tests, aldrin, at the rate of 4 pounds an acre, when mixed with a commercial fertilizer and applied to soil in which peanuts were being grown, gave a 100-percent control of the rootworm. Neither benzene hexachloride nor lindane can be recommended for the control of the corn rootworm on peanuts because both impart an off-flavor to the harvested peanuts.

Rhodes-Grass Scale Hard Hit by Freeze and Drought

The Rhodes-grass scale has been recorded from 106 counties and parishes in the United States, including 55 in Texas, 25 in Louisiana, 3 in Mississippi, 1 in Alabama, and 22 in Florida. It has been found infesting 60 host plants. In southern Texas, however, where the scale has been of economic importance as a pest of Rhodes-grass, the unusually cold winter of 1950–51 and an extended drought reduced the number of insects to a very low, noneconomic level.

The range grasses Angleton bluestem, Brahman grass, and K–R bluestem are apparently resistant to the Rhodes-grass scale. One of the systemic insecticides may be practical for use in controlling the scale on lawns and golf courses.

The studies were conducted with funds authorized under the Research and Marketing Act.

European Corn Borer Spreads Into Seven More States

Further spread of the European corn borer was recorded in 1950, when the pest was found for the first time in Alabama, Arkansas, Colorado, Georgia, Mississippi, Oklahoma, and South Carolina. In addition, nine States previously infested reported dispersion of the borer within their boundaries. The number of counties known to be infested was increased by 5 in Illinois, 15 in Kansas, 6 in Kentucky, 1 in Minnesota, 5 in Nebraska, 3 in North Dakota, 1 in South Dakota, 32 in Tennessee, and 6 in Virginia.

Heavy flights of moths and extensive egg laying in June and July pointed to a damaging infestation of borers in the Corn Belt in 1950. However, the weather was very unfavorable to the borer. Development of first-generation larvae was retarded, their survival was low, and an unusually small percentage of them pupated. Second-generation moth flight and egg laying were much less than expected. Annual fall surveys by State agencies, in cooperation with the Bureau, showed that borer numbers in 1950 were materially lower than in 1949 over much of the infested area. Corn borer numbers in the Eastern States remained at the low level of 1949. In the North Central States the borer showed a general decline in numbers from 1949.

Damage by the corn borer in 1950 was estimated at 58,765,000 bushels of field corn, valued at $84,912,000. The bushel loss was about 81 percent less in 1950 than in 1949.

The Bureau continued to assist State agencies in providing information for growers and other interested groups on the need for and proper use of insecticides to control the corn borer. In 1950 the program was expanded to include 14 States.

Collections were made of parasites of the corn borer that had been imported into this country and had become well established in the vicinity of older colony sites. Approximately 160,000 parasites, comprising 7 species, reared from borers collected in this country, were released in 1950 in areas more recently invaded by the borer. Appreciable numbers of the pest are being destroyed by these enemies.

Distribution of DDT Residues on Corn Determined

Studies of DDT residues on corn were carried out in cooperation with a manufacturer of the insecticide. Types of formulations used, distribution of DDT on the plants, methods of application, and time of application were considered.

DDT emulsion sprays left larger deposits on corn plants than a suspension of DDT wettable powder. Dust applications left smaller deposits of DDT than sprays. Aerial applications left smaller deposits than ground applications.

The distribution of residue on different parts of the corn plant followed a fairly uniform pattern for all the formulations and types of equipment. The leaves retained from 70 to 90 percent of the insecticide applied; the whorl or top generally carried 15 to 25 percent; and the stalk, from 5 to 10 percent. After a short weathering period there were indications that residues from dusts and suspension sprays were lost rapidly from leaf surfaces and lodged on the stalk. This was not true of emulsions.

Study of dates of application for control of European corn borer on field corn showed that weathering was more important than growth in reducing DDT residues.

Some Wheats and Barleys Resistant to Hessian Fly

The high resistance to the hessian fly of the wheat variety P. I. 56206–8 has been transferred to a number of soft winter wheats. This variety is also resistant to the race of fly that attacks W38, another generally fly-resistant wheat. Another fly-resistant wheat, 3848–36, although it does not meet milling requirements, is showing promise in Indiana as an early-sown wheat for fall grazing and erosion control. An outstanding hard winter wheat, C. I. 12128, which has high resistance to the hessian fly as one of its desirable characters, is being increased for early release in Kansas and Oklahoma.

Seven varieties of barley among 5,112 strains tested in the greenhouse had very low plant infestations under heavy attack by the hessian fly. Studies of the inheritance of the resistance in crosses of some of the varieties are in progress and the eventual development of an agronomically desirable fly-resistant barley is anticipated.

The investigations on resistance of wheats and barleys to the hessian fly were conducted in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and the agricultural experiment stations of Indiana (Purdue), Kansas, and other States.

Small Grains Threatened by Greenbugs and Other Pests

Small grains in Oklahoma, eastern New Mexico, and the Texas Panhandle, in the spring of 1951, were severely infested with greenbugs,

army cutworms, crown aphids, or brown wheat mites. Parathion continued to be effective for control of the greenbug and was applied over a wide area. However, generally poor development of the wheat plants and prospects of low yields because of factors other than greenbugs probably deterred many growers from applying insecticides. Windy weather in the greenbug-infested area was unfavorable for airplane applications of parathion, and temperatures below 50° F. reduced the effectiveness of the insecticide. Colonization of ladybugs to feed on the greenbugs in Oklahoma had little control value. The greenbugs were so numerous in the grain fields that their control by ladybugs would have been too costly. Cutworms were controlled in preliminary tests with nitroparaffins, DDT, dieldrin, parathion, toxaphene, and chlordane.

Control for Red Harvester Ant Improved

Better control of the red harvester ant in alfalfa fields in Arizona has been obtained in preliminary tests with dieldrin and chlordane. Dieldrin was used as a 2- or 2.5-percent dust and chlordane as a 5-percent dust. Fumigation of the colonies with bromotrichloromethane was also promising for the control of this ant.

INSECTS AFFECTING MAN

Research on insects affecting man was important to both the agricultural and the military activities of this country. An example of a major contribution to entomological research for the military is the temporary assignment of a specialist in the classification of flies as consultant to United States Naval Medical Research Unit 3 in Cairo, Egypt, to study a complex problem involving the identification of various Egyptian species in the house fly genus *Musca*. Particular attention was given to resistance of the several species to insecticides. As a result of the studies, advice was given on the type of research that might be most successful. The recommendations significantly affected the trend of the research projects.

This and similar research for the military were supported by funds transferred to the Bureau by the Department of Defense.

Community-Wide Tick-Control Programs Prove Successful

The American dog tick, carrier of Rocky Mountain spotted fever, was controlled successfully in townships on Cape Cod. Community-wide control programs were carried out on an experimental basis by the Departments of Conservation and Public Health of the Commonwealth of Massachusetts, with assistance and technical supervision by entomologists from the Orlando, Fla., laboratory.

DDT sprays, applied at the rate of 1 pound of DDT an acre to vegetation along roadways, paths, and other places where ticks congregate, satisfactorily controlled the pest. The project was sponsored in part by the Army Committee on Insect and Rodent Control.

Search Continues for New Mosquito Insecticides

The appearance in Florida and California of strains of mosquitoes resistant to DDT has necessitated reevaluation of several insecticides

and a search for new materials to use as alternate treatments. Benzene hexachloride and lindane insecticides were used successfully in the summer of 1950 by Florida mosquito-abatement districts and by the Department of Defense in areas where DDT-resistant strains of salt-marsh mosquitoes were prevalent. In preliminary field evaluations, heptachlor has shown promise as an effective insecticide against both adults and larvae.

House Flies Develop Resistance to New Insecticides

The use of new insecticides to replace DDT has not solved the problem of controlling DDT-resistant strains of house flies. In the vicinity of Orlando, Fla., house flies resistant to DDT have developed within one season a high degree of resistance to lindane, chlordane, dieldrin, and toxaphene. Flies around some dairies in that area cannot be controlled by the sole use of any insecticide now available, including pyrethrum.

The possibilities of utilizing baits along with rigid sanitation practices are being studied in efforts to control flies. Various agricultural products, such as molasses, fermenting grains, and dried milk, are being evaluated as attractants for house flies. The addition of ammonium carbonate to baits appears to enhance the attractiveness of such baits.

House Flies Survive Lifetime Exposure to DDT

Physiological studies indicate that insecticides of residual types, such as DDT, methoxychlor, lindane, dieldrin, and aldrin, may eventually become completely ineffective as a control for house flies unless some way is found to overcome the resistance to them that rapidly develops in the flies. Laboratory strains of house flies have now been bred that spend their entire adult life and lay eggs while confined in cages thoroughly coated with deposits of DDT.

Flight Range of Flies Studied With Aid of Radioactive Isotopes

Studies were carried out by the Corvallis, Oreg., station, in cooperation with Oregon State College, to gain more information on the migration habits of the house fly, the green-bottle fly, and the black blow fly.

Flies reared in the laboratory were given water containing radioactive phosphoric acid so that they could be readily detected with Geiger counters or other equipment. A total of 35,000 house flies, 15,000 green-bottle flies, and 1,200 black blow flies marked with radioactive phosphoric acid were released in the Willamette Valley near Corvallis. Within 24 hours flies of all three species were taken in traps 4 miles from the point of release. Later, house flies were recovered 12 miles from the release point, black blow flies 4 miles, and green-bottle flies 8 miles. In addition, a high percentage of the marked flies were recovered in 24 small traps operated within 18 miles from the point of release.

The percentage of recovery of the different species at all points was as follows: House fly, 4.6 percent; green-bottle fly, 3.6 percent;

and black blow fly, 14 percent. More flies were trapped around farm buildings than in open areas.

Radioactive DDT Used to Study Sites of Action of Insecticides

Studies of the distribution of radioactive DDT in house flies showed that approximately 70 percent of the insecticide was absorbed by the cuticle and the rest by the internal organs and tissues. More DDT is required to kill house flies when absorbed through the dorsal surface of the thorax from local applications than when absorbed through the feet from residual deposits. Absorption of DDT into the cuticle continues after flies have been killed with DDT.

Mosquito larvae exposed to DDT suspensions in water showed higher kills at 70° than at 95° F. However, the amount of DDT absorbed by the larvae was about the same at each temperature. Bio-assay of acetone extracts from the two groups of second-instar larvae used as test insects showed that the insects exposed to DDT at 95° F. had decomposed a higher percentage of absorbed DDT.

Clear Lake Gnats Controlled With TDE Larvicide

No adults of the Clear Lake gnat were found during 1950 in Lake County, Calif., by local mosquito- and gnat-abatement officials. Several years of research by this Bureau, in cooperation with California State agencies, to develop control measures for the Clear Lake gnat culminated, in the fall of 1949, in the treatment of the 40,000-acre lake with TDE. Apparent complete control of the gnat larvae was reported last year. The absence of the Clear Lake gnat in the summer of 1950 confirmed the efficacy of the treatments.

Cultivated Heliopsis Plants Yield Extract More Toxic to House Flies Than That From Wild Plants

Petroleum-ether extracts prepared from the roots of *Heliopsis scabra* and *H. parvifolia* plants, grown in experimental plots at Sacaton, Ariz., and Beltsville, Md., by the Bureau of Plant Industry, Soils, and Agricultural Engineering, proved to be more toxic to house flies than extracts from roots of the parent wild plants. The extractive from 6-month-old *H. scabra* plants grown at Sacaton was more toxic than that from the 11-month-old Beltsville plants, but the reverse was true of *H. parvifolia.* The extractive from the *H. scabra* root grown at Sacaton was more toxic to house flies than that from any sample of the plant previously obtained.

A sample of *Heliopsis scabra* collected at Cloudcroft, N. Mex., on extraction yielded the highest percentage of scabrin (0.37 percent of dry root) thus far obtained from the species.

Heliopsis helianthoides was found growing abundantly in a field near Circleville, W. Va. The extractive from a sample of this root was separated into three fractions, one of which appeared to consist mainly of scabrin.

In tests against German roaches, scabrin was toxic in refined kerosene solution, but not very effective when applied as a pyrophyllite dust. Refined kerosene solutions of scabrin were highly toxic to house flies when tested by both the turntable and Peet-Grady methods.

When incorporated in an aerosol, however, the scabrin showed little effect on the house fly. Antibiotic tests with scabrin showed it to be effective against more than a dozen species of bacteria and fungi. It was somewhat toxic to rats, when fed by stomach tube, the minimum lethal dosage ranging from 50 to 200 milligrams per kilogram of body weight.

The studies were conducted with funds authorized under the Research and Marketing Act of 1946. They do not now warrant definite recommendations.

New Materials Studied as Possible Insect Repellents

Work on insect repellents at the Orlando, Fla., laboratory was concentrated on the development of materials that can be applied to clothing to protect the Armed Forces from attack by mosquitoes, mites, flies, and ticks. Repellents or toxicants found useful against the different arthropods are then combined in order to develop a general-purpose treatment. One such composition, designated M–1960, gave very promising results. M–1960 is composed of 30 percent each of 2-butyl-2-ethyl-1, 3-propanediol, benzyl benzoate, and *n*-butyl acetanilide. Ten percent of an emulsifying agent is added so that the material can be diluted with water, the form in which the composition is used to treat clothing.

Snow-Water Mosquitoes Controlled in Oregon Resort Areas

Practical control of snow-water or mountain mosquitoes in the higher elevations in the Pacific Northwest appears possible through use of portable or fixed spray equipment to treat resort areas. Satisfactory relief from mosquitoes was obtained by spraying with DDT or pyrethrum each day. Just before and after dusk, when adult mosquitoes show a marked tendency to migrate, DDT sprays did not always provide adequate relief, and pyrethrum sprays were sometimes required. However, treatment with DDT during the day gave good control of the insects in the immediate vicinity of the camp until the dusk migration began.

Treating Mosquito Breeding Grounds in Alaska Reduces Following Season's Mosquito Population

Mosquito-control research in Alaska demonstrated that as little as 0.3 to 0.4 pound of DDT an acre applied to an area of 100 square miles reduces mosquito numbers the following season by 95 percent.

Application of Insecticides to Breeding Areas Offers Promise in Control of Sand Fly

Joint investigations by Florida mosquito-abatement districts, the Florida State Board of Health, and the Orlando, Fla., laboratory showed that either dieldrin or chlordane applied to marsh areas where sand flies breed provides excellent control of the larvae for several months. In small-scale tests, dieldrin at the rate of 1 pound and chlordane at 2 pounds an acre showed particular promise.

Keys to Identification of Troublesome Pests in Alaska Supplied

Because of the importance of biting midges and black flies to military operations in Alaska, the taxonomy of these annoying pests has been intensively studied. Keys and charts to assist in their identification have been prepared for publication.

INSECTS AFFECTING ANIMALS

New Screw-Worm Remedy Developed

Recommendations for a new screw-worm remedy were released as a result of several years' study at the Kerrville, Tex., laboratory in cooperation with the Bureau of Animal Industry. The new preparation, designated EQ–335, contains 3 percent of lindane, 35 percent of pine oil, 42 percent of mineral oil, 10 percent of silica aerogel, and 10 percent of an emulsifying agent. EQ–335 is superior to Smear 62, the remedy developed by the Department and used extensively and successfully by stockmen since 1940. Wounds are adequately protected from infestation if the preparation is applied once a week. It does not stain wool or clothing, as did Smear 62, and it is less likely to deteriorate in storage. Screw-worm flies visiting treated wounds to oviposit or to feed are killed by the lindane residue on the wound. This feature of the new remedy may prove of particular importance in reducing screw-worm numbers.

Unique Approach to Screw-Worm Control Studied

A unique method is under investigation as a possible aid in the control or eradication of the screw-worm in restricted areas. The method involves the exposure of specially reared flies to X-rays and their release among the wild population when this population is at its lowest seasonal ebb. It has been demonstrated in the laboratory that both male and female flies emerging from pupae exposed to approximately 5,000 roentgen rays are sterile, although their normal mating behavior is not affected. Of special significance is the fact that female screw-worm flies mate only once. Once mated to males made sterile with X-rays, normal females will not later mate with normal males; consequently, the eggs they produce are infertile. Adult females exposed to X-rays are also sterile. In caged flies of both sexes, X-ray sterilized and normal in the ratio of 5 to 1, about 80 percent of the normal females produced infertile egg masses.

Screw-worm numbers vary greatly. In winter the number may drop low enough to make it economically feasible to rear, expose to X-rays or other radiations, and release the flies in numbers larger than the number of wild flies. Continued release of sterile flies over a period of months might reduce the biotic potential of wild flies to the point where control or eradication of the insect could be achieved. The practical possibilities of this method of control cannot be estimated until field studies are conducted.

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Studies of Biology and Control of Horse Flies Provide Significant Facts

The biology of several species of horse flies was studied in Oklahoma and in Florida, in cooperation with the State experiment stations. Methods of rearing larvae under laboratory conditions were developed. Earthworms, snails, and tendipedid larvae were among the foods that appeared to be satisfactory. The studies were made under funds authorized in the Research and Marketing Act.

Habitats for the larvae of several species have been located in Oklahoma and in Florida. Of special significance is the finding that *Tabanus sulcifrons*, an important species in Oklahoma, will develop in relatively dry soils.

Studies at Kerrville, Tex., show that sprays containing pyrethrum and tall oil are less expensive and equally or more effective in protecting cattle from attack by tabanids than are the combinations of pyrethrum with piperonyl butoxide or with other pyrethrum synergists. None of the pyrethrum sprays are now considered practical for protecting range cattle from attack by tabanids.

High- and Low-Pressure Spray Applications Nearly Equal in Effectiveness for Control of Cattle Grubs

The mortality of third-instar larvae of cattle grubs was about as high when rotenone sprays were applied at a pressure of 150 to 200 pounds as at 400 to 450 pounds, as disclosed by studies in Texas, Oregon, and Georgia, in cooperation with the State experiment stations. The number of second-instar larvae present in the animals was too low to permit evaluation of the effectiveness of the different pressures against this stage of the grub. The addition of 0.5 percent of a commercial detergent to the spray mixture caused no significant increase in kill of the larvae.

Although it is recommended that rotenone sprays be applied at pressures of 400 pounds or higher, the results from lower pressures compared favorably with those from higher pressures, under conditions of the tests. If high-pressure spray equipment cannot be obtained for grub control, stockmen are encouraged to treat their animals with available equipment that has a pressure of 200 pounds or higher.

Improvement in Livestock Dips Sought

Insecticide dips made from some of the new insecticides are subject to deterioration on long standing in dipping vats. Toxaphene-emulsion dip, one of the most economical and effective dips for controlling ticks and other pests on cattle, may deteriorate after varying periods of time, depending on the source of water and other factors. The deterioration of the dip creates hazards to the animal and may cause erratic results in controlling the parasites. Several toxaphene formulations under investigation appear superior to commercial formulations now available to the public. Further field studies are necessary, however, before the formulations can be recommended for practical dipping operations.

This work was finance with funds authorized under the Research and Marketing Act.

Measures to Control Imported Fire Ant Studied

The imported fire ant, an important introduced species abundant in parts of Alabama and Mississippi, has been found in other States in the Southeast. Infestations have been found in a total of 78 counties or parishes in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Tennessee.

Shipment of nursery stock from infested areas is probably the most important way of spreading the pest to new areas.

Chlordane applied as a spray or dust to individual ant mounds or to infested areas will give good control of the ant. Preliminary tests show heptachlor to be equal or superior in effectiveness of control.

HOUSEHOLD INSECTS

Several Insecticides Tested for Control of Ants in Homes

The degree and duration of ant control in homes from the use of some of the available insecticides were determined in the Savannah, Ga., area. Chlordane, now widely employed as a 2-percent spray for the purpose, proved superior to other materials. Proper treatment of homes provided good control of ants for at least 4 months. Lindane used as a 0.5-percent spray gave a shorter period of protection than chlordane, but a longer one than 5-percent DDT sprays. Pyrethrum and piperonyl butoxide were least effective of the four materials tested.

Stored Woolens Can Be Protected Against Fabric Pests for 3 Years

Investigations in cooperation with the Department of Defense were continued on means of protecting fabrics from attack by clothes moths and carpet beetles. It was demonstrated that impregnating wool cloth with DDT at the rate of 0.3 to 0.4 percent of the weight of the cloth protects rolls of cloth in storage for at least 3 years. Spraying the outer surface of the rolls with DDT also gives excellent protection. Special equipment has been designed and constructed for spraying rolls of cloth before storage. These developments will reduce the cost of protecting fabrics in storage and provide almost complete protection against insect damage for at least 3 years.

Further Developments in Control of Fabric Pests Look Promising

Sprays containing combinations of DDT and chlordane or DDT and lindane also showed promise for controlling fabric pests. Spraying infested rolls of woolen cloth with such combinations controlled existing infestations through contact and vapor toxicity of the chlordane or lindane. DDT provided long-lasting protection against reinfestation. Results of preliminary tests indicate that infestations of carpet beetles or clothes moths in raw wool can be controlled and the wool protected from further infestations by spraying the outside of the bags with the combination sprays.

Lindane proved useful in several other ways for controlling fabric pests in homes. Treating the inside walls of storage chests with lindane at the rate of one-half gram of lindane to a square foot of sur-

face, through action of lindane vapors, protected cloth from fabric pests for at least 6 months. Preliminary tests indicated that vapors from lindane applied to the under side of a rug will penetrate the whole rug and destroy fabric pests in it. Studies showed that DDT and methoxychlor are among the most effective of the available insecticides in preventing feeding damage by moths and carpet beetles to fabrics.

Feathers treated with 0.85 percent by weight of DDT and aged 30 months were still completely resistant to feeding damage by clothes moths or carpet beetles. Wool and hair felts were likewise protected for the same period. The experiments to determine this resistance were performed with funds authorized under the Research and Marketing Act.

Synthetic bristles made from casein, impregnated with 1 percent of DDT during manufacture, were found to be immune or highly resistant to carpet beetles after aging for 18 months. Untreated bristles were heavily damaged. This work also was performed with funds authorized under the Research and Marketing Act.

Protection of Military Subsistence Items From Insect Attack Investigated

Special investigations are under way to develop means of protecting flour and other foodstuffs for the Armed Forces from insect damage. Cloth and paper bags impregnated with various insecticides and filled with flour are being tested under warehouse storage conditions. The flour is subject to infestation by all the more important flour pests. Pyrethrum in combination with certain synergists offers the most promise as a means for protecting the bagged flour from insect damage.

TOXICOLOGY OF INSECTICIDES

The problem of the potential hazards of new chemicals to man and animals continues of foremost importance in connection with the development of insecticides. The Bureau of Entomology and Plant Quarantine, the Bureau of Animal Industry, and the Bureau of Dairy Industry have continued a cooperative investigation to determine the effects of the newer insecticides on livestock and the extent to which they remain as residues on or in animal and plant products.

The studies are being conducted in cooperation with the Texas Agricultural Experiment Station, with funds authorized under the Research and Marketing Act.

Toxicity of Dieldrin to Livestock Determined

Dieldrin is among the most effective of the available insecticides for controlling pests of livestock and man. Special investigations were undertaken to determine its toxicity to livestock. Sprays containing 0.1 percent of dieldrin had no apparent toxic effects on eight calves less than 1 month old. When the concentration was increased to 0.25 percent, 6 of 11 calves were killed. Lambs and pigs tolerated concentrations of 2-percent dieldrin sprays without apparent harmful effects. A single application of a spray containing 1 percent of

dieldrin was tolerated by yearlings with no toxic effects. Repeated applications of a 0.5-percent spray at 2- and 3-week intervals produced toxic effects but no deaths. Application of sprays containing 0.25 percent of dieldrin on eight beef animals at 3-week intervals had no apparent toxic effects. Comparable data on other insecticides indicate that dieldrin as a spray is at least four times as toxic as chlordane or toxaphene to young calves and from one-half to one-fifth as toxic as the gamma isomer of benzene hexachloride.

Fat of Sprayed Livestock Tested for Presence of Insecticides

Investigations were continued to determine the extent to which insecticides applied repeatedly for controlling livestock pests or consumed as residues on feeds are stored in the fat of cattle.

Of special importance was the observation that animals sprayed at 3-week intervals reached the maximum storage of insecticide after two or three treatments. Thereafter the rate of storage and elimination of the insecticide reached equilibrium.

DDT was applied as a 0.5-percent emulsion spray to cattle at intervals of 2 weeks. Biopsy samples of fat taken from the animals showed that after 28 to 36 treatments the DDT content of the fat of 12 animals averaged approximately 85 p. p. m. (parts per million). No harmful effects of the DDT treatments were apparent. The animals showed weight gains equal to those of untreated control animals.

As a 2-week treatment schedule with DDT is not standard practice in livestock-pest control, a similar experiment was conducted following the usual 3-week schedule. After six treatments the fat from the animals averaged about 35 p. p. m. of DDT. TDE in a similar experiment gave similar results.

The application of sprays containing 0.03 percent of lindane to cattle at 3-week intervals caused no detectable storage of lindane in fat of the animals. Cattle treated at 3-week intervals with 0.5 percent methoxychlor sprays showed only 2.4 p. p. m. of methoxychlor in fat following six applications.

Dieldrin applied as a 0.05-percent wettable-powder spray resulted in increases of organic chloride in the fat equivalent to 24 p. p. m. of the insecticide after three treatments at 3-week intervals.

A single treatment of cattle with 0.5-percent chlordane sprays caused no significant increase of organic chlorides in the fat. Single treatments with DDT resulted in deposition of about 11 p. p. m. in the fat. Similar results were obtained with TDE.

Beef cattle given a diet containing 10 p. p. m. of methoxychlor showed no detectable methoxychlor in the fat 30 days after feeding began. Similarly, beef cattle showed no significant increase in organic chlorides in the fat following 30 days on a diet containing 10 p. p. m. of toxaphene.

Two beef animals and two sheep kept for 2 months on a diet containing 25 p. p. m. of chlordane showed an increase in organic chlorides in the fat equivalent to about 16 p. p. m. of chlordane in cattle and 11 p. p. m. in sheep. A like group of animals on a diet containing 25 p. p. m. of aldrin showed an increase of organic chlorides equivalent to 78 p. p. m. of aldrin in both the cattle and sheep. Similar results were obtained with dieldrin.

Insecticidal Residues in Milk of Sprayed Dairy Cattle Determined

Application of an emulsion spray containing 0.5 percent of dieldrin to a dairy cow resulted in excretion of a maximum of 8.3 p. p. m. of dieldrin in milk, as determined by bio-assay tests by the manufacturer of the insecticide. A similar treatment of a cow, using a wettable-powder spray, resulted in a maximum of 4.2 p. p. m. Determinations of organic chloride in milk at the Kerrville, Tex., laboratory gave results comparable with those obtained by bio-assay.

The application of 0.03-percent lindane sprays to four dairy cows at intervals of 10 days resulted in about 0.5 p. p. m. of lindane in milk the day following treatment. The lindane content of milk by the third day was so low the data were of questionable significance. There was no indication that repeated treatments at 10-day intervals resulted in progressive increase in the amount of lindane in milk following each treatment.

Treatment of four dairy cows with a 0.5-percent methoxychlor spray, as used for fly control, resulted in an average of about 0.15 p. p. m. of methoxychlor the first week after treatment. During the second and third weeks the average in the milk was less than 0.05 p. p. m.

FRUIT AND NUT INSECTS

Oriental Fruit Fly Investigated

Wide variety of control measures found available

The diversified activities in which the Bureau, the University of California, the California Department of Agriculture, the Hawaiian Agricultural Experiment Station, the Territorial Board of Commissioners of Agriculture and Forestry, the Pineapple Research Institute, and the Hawaiian Sugar Planters' Association have cooperated have developed a variety of control measures, some of which have already been of direct benefit to Hawaiian farmers. Other measures, though still being developed, have shown exceptional promise. The information being developed and that now available on methods for controlling the oriental fruit fly are important resources in readiness should this fly evade the rigid controls set up to prevent its introduction into the United States mainland.

Foreign parasites vigorously attack oriental fruit fly in Hawaii

Control of the oriental fruit fly in Hawaii by introduced natural enemies has caused spectacular drops in fly numbers in some areas and a definite decline in others.

More than 20 species of parasites and 1 species of predator have been imported and released on the islands. Of these, only three species of parasites are important thus far, one species predominantly so. Checks on the effectiveness of the parasites show that it is now possible to find wild guavas that are entirely free from the oriental fruit fly. The drop in guava infestation appears to be associated with a somewhat general decline in fly numbers. There is enough evidence, however, to assume that reduction to the present infestation of guavas is largely due to parasite activity. A similar result cannot be foreseen at this time in the fly's other host fruits. It is not anticipated that

the biological control of the fly will ever eliminate the need for careful quarantine safeguards, treatments of fresh fruits and vegetables for export, or the use of insecticides to protect certain of the more susceptible hosts, such as mango and avocado.

Tropics searched for oriental fruit fly parasites

The search for natural enemies of the oriental fruit fly, in progress since 1948, continued. Shipments of field-collected fruit fly puparia from India, Siam, the Philippine Islands, Borneo, and Africa totaled about 1,725,000 puparia. From these, about 60,000 parasites, representing 31 species, were reared.

This work was partly financed by funds authorized under the Research and Marketing Act.

New commodity treatments ease pinch on fruit exports from Hawaii

Studies on the preexport treatment of fruits and vegetables susceptible to infestation by the oriental fruit fly resulted in the adoption of a fumigation method that has greatly simplified the whole problem of commodity treatments. It was found that ethylene dibromide is extremely toxic to fruit fly eggs at very low dosages. As little as one-half pound of this fumigant to 1,000 cubic feet with a 2-hour exposure insures complete destruction of all fruit fly stages. Extensive tolerance tests showed that Hawaii-grown avocado, bell pepper, bitter melon, Cavendish bananas, cucumber, papaya, pineapple, string beans, and zucchini squash will stand such treatment without injury. The vapor-heat treatment was also successfully applied to pineapples that had been conditioned prior to heating.

The new fumigation method will have a stimulating effect on the development of small-grower agriculture in the Hawaiian Islands, now that most important commodities may be grown with the assurance that they can be qualified for export. California cooperators have also determined that this type of fumigation would be suitable for many of their fresh fruits and vegetables.

Several chemical controls effective against oriental fruit fly

The results of a large-scale test with a methyl eugenol-parathion lure that attracts and kills male flies suggest that this method may provide substantial and cheap control of the fruit fly when applied on an area-wide basis. However, the lure needs further experimental evaluation in field tests to determine its ultimate worth. A newly developed olfactometer that is convenient, reliable, and effective greatly speeded the screening of possible attractants and repellents.

Active ingredients in moderately large quantities in formulations containing lindane, parathion, dieldrin, and aldrin have effectively killed flies during their pupal stage in the soil. These insecticides offer a wide choice of materials for a localized eradication program. They, as well as EPN, Dilan, and DDT, at concentrations commonly used in orchard spraying, were found to be effective both as residual and contact poisons. How much protection they will give when applied to fruits growing in commercial plantings and home gardens will be determined by further study.

Parathion, dieldrin, and aldrin have also functioned as fumigants in controlling the fly. Parathion, furthermore, may be highly effec-

tive as a poisonous contaminant of the fly's basic food supply. This is indicated by the fact that an effective bait spray can be made with parathion in combination with protein hydrolysate and sugar. This bait spray is also effective against the Mediterranean fruit fly and the melon fly.

No serious effects on beneficial insects were observed following the use of at least five of the compounds tested. Even though further research should result in refinements of methods and the discovery of effective materials or formulations better suited for widespread applications in populated areas, it is believed that data necessary for the intelligent use of insecticides in an eradication program are now available.

Eradication nearly accomplished on Lanai

A large-scale control program was undertaken on the island of Lanai following a year of basic preparation in test areas. The operation comprised a series of large-scale experiments that together covered the known fly-breeding and concentration areas on the island. The control achieved can be evaluated by the fact that fly collections from banana trap-fruit at Lanai City were completely negative for 4 months. Complete eradication was not expected because of reinfestation by flight from other islands. The control operation was considered a complete success and one that could be duplicated in case of an incipient infestation on the United States mainland.

Life-history studies develop basic information

Controlled laboratory experiments by a physiologist have confirmed field observations that temperatures below 60° F. generally inhibit the mating of sexually mature flies, but that a decreasing light intensity, not necessarily dusk, is a primary factor in the inhibition. The use of carbon dioxide as an anesthetic greatly assisted in the critical examination of flies in the laboratory.

The biology and ecology of the fly have been studied on the mountains on Hawaii and Maui up to altitudes of 9,200 feet. Basic information has been obtained on longevity and the preoviposition period, as well as egg, larval, and pupal survival in both favorable and marginal areas. The studies provide a basis for estimating the survival possibilities of the fly on the mainland. Several new and unique instruments to simulate mainland temperature and humidity were devised to facilitate the studies.

Close to 5 tons of fruit, including 300,000 individual fruits, was collected in the field. The collections yielded information on fly parasite complexes, host preference, and host sequences under which fly populations may be built up. About three-quarters of a ton of California-grown host material was received for exposure to fly attack and determination of its susceptibility to infestation.

Incidental observations show that Mediterranean fruit flies and melon flies are also a hazard to agriculture in the States.

Citrus Blackfly Investigated

Survey for citrus blackfly continued

Surveys in northern Mexico were continued to spot incipient infestations of the citrus blackfly so that they might be suppressed before

the flies became so numerous and so widely distributed that they could readily spread into citrus groves across the border. Survey crews operated in the States of Tamaulipas, Nuevo Leon, and Sonora and in Baja California, in areas contiguous to citrus plantings in Texas, Arizona, and California. Infestations were found on citrus trees in all the areas except Baja California.

The work was done in cooperation with the Mexican Department of Agriculture and local Mexican blackfly committees. A number of Bureau inspectors and supervisors worked with a larger number of inspectors supplied by the cooperating Mexican agencies. More than 375,000 trees on almost 30,000 properties were inspected. Blackfly infestations were found on 924 citrus plantings. Many of the infestations were very light; most were on dooryard plantings rather than on trees in groves. Application of sprays, under the exclusive direction of the Mexican Department of Agriculture and the Mexican blackfly committees, gave excellent control of the fly.

Citrus blackfly fought in Mexico

Research on the citrus blackfly continued in cooperation with Mexico.

Experimental attrition spraying in the Guaymas area reduced the number of infested properties from 282 to 58 and the number of trees in the spray program from 20,000 to 8,000. Citrus blackflies on the remaining infested trees were reduced to negligible numbers.

A new infestation on April 30, 1951, near the main highway in Hermosillo, Sonora, received a first clean-up spray application beginning May 3.

In the generally infested area in the east citrus production has been doubled in groves sprayed experimentally twice a year. Both speed and hydraulic spraying have given effective commercial control in this area.

Extremely dry weather, both in the west and in the east has slowed up multiplication of the blackfly and in the east where infested plants in the wilds have lost their leaves because of drought it apparently has eliminated a number of infestations. Immature stages on leaves in undefoliated areas, however, survived a freeze of 23° F. and multiplication continued.

Traps attractive to blackfly adults were used in the field to evaluate the progress of clean-up spraying and to determine the spread of the fly.

Experiments using processed oils of high paraffin content and viscosity resulted in the development of a dip for packed limes that does not injure the fruit or affect its flavor, yet kills the blackfly. Dips using horticultural oils have either injured the fruit or given it an off-flavor.

Imported citrus blackfly parasites thrive in Mexico

Four of the seven species of parasites imported by the Bureau from semiarid sections in India and Pakistan and released early in 1950 in dry areas in Mexico have become established and are increasing in numbers and spread. One of them, *Prospaltella smithi* Silv., has gone through the dry season with a steady increase in the rate of parasitization. Nearly 30,000 adults of the species were collected

from the original colonization tree during a few months for recolonization in other parts of Mexico.

Experiments Confirm Value of Parathion in Control of Scale Insects on Citrus

Parathion has marked advantages over oil sprays for the control of scale insects on citrus, according to the results of experiments recently completed in Florida. Parathion may be added to regularly scheduled sulfur sprays used against the citrus rust mite, whereas the oil spray may not be combined with sulfur, so that extra sprayings are necessary. In the experiments two sprayings with wettable sulfur plus parathion (1 or 2 pounds of 15-percent wettable powder), in midsummer and fall, gave as good control of purple scale and Florida red scale as did two of the oil, and at the same time controlled the rust mite. A combination spray of wettable sulfur, wettable parathion, and bis(*p*-chlorophenoxy)methane (Neotran), when used in July and in the fall gave good control of the rust mite, purple scale, and the citrus red mite without harm to Valencia orange trees. Parathion had no unfavorable effect on the quality of the fruit. Actually, it advanced the maturity of oranges slightly. In contrast, oil sprays applied late in the summer or in the fall lowered the quality of the fruit and delayed its maturity.

In California one annual application to citrus of a spray of parathion with 1.75 percent of a special light oil (lighter than any of the light oils registered in California) continued to give better control than two applications of a heavier oil alone. Fall spraying gave more clean lemon fruits than spring spraying. Other experiments indicate that in commercial sprays containing 1 pound of 25-percent parathion wettable powder to 100 gallons, oil concentration may be reduced without reducing effectiveness. One gallon of oil plus 0.5 pound of parathion to 100 gallons of water was superior to the full dosage of oil alone. This reduced amount of oil lessened some of the objectionable effect of oil sprays.

Addition of 2,4-D to sprays containing parathion and oil continued to prevent leaf drop on lemons in California. In some areas there was no leaf drop whether or not 2,4-D was added. Sprays of 1.5 gallons or more of oil plus 0.5 pound of 25-percent parathion to 100 gallons have sometimes caused injury to oranges. No injury followed the application of 1 percent of oil with parathion.

A spray containing the special light oil plus parathion injured oranges less than regular oil sprays in most tests, but more in one test. There was no injury of commercial importance from parathion alone. Special light oil plus parathion and parathion alone caused no reduction in quality or delay in maturity of oranges.

Experimental results and commercial experience in California confirmed earlier conclusions that thorough application and an adequate dosage of parathion are necessary for satisfactory control of California red scale. When an infestation is distributed over all parts of the tree, at least 2 pounds of a 25-percent wettable powder to 100 gallons is needed. With very light infestations on green twigs and fruit, more dilute sprays give good results.

Improved Methods of Applying Insecticides to Orchards Studied

Because of possible large savings in labor costs and some savings in material, many orchardists have shifted from conventional orchard sprayers to mist blowers and other new types of sprayers or dusters. Developments in this field have been due largely to the high degree of effectiveness of DDT, parathion, TEPP, and other new insecticides with less complete coverage than was required with older insecticides.

Data obtained in Washington orchards showed that the codling moth was nearly wiped out in one orchard sprayed three times with a speed sprayer, using parathion or DDT at two or four times the usual concentration, in another dusted twice with a high-power duster, and in a third dusted twice with an airplane. Fruit infestations not exceeding 8 percent were observed in other orchards treated with different types of new equipment, including a helicopter. It is evident that satisfactory control can be obtained with several different methods of applying insecticides. This is especially true in orchards with low codling moth populations.

Further possibilities of the newer methods of applying insecticides were indicated in tests and observations in Indiana, Louisiana, and Florida. In Indiana the codling moth was controlled as effectively with materials applied with a mist blower as when they were applied in dilute form with a speed sprayer. A concentrated mist spray containing parathion, copper sulfate, and lime approached in effectiveness dilute sprays containing wettable sulfur in combination with dinitro-*o*-cyclohexylphenol or parathion in controlling the mite *Tetranychus hicoriae* McG on pecans in Louisiana. Pecan growers were also able to control light infestations of the black pecan aphid with mist sprays. In Florida mist-blower applications of parathion were effective against the pecan nut casebearer.

Analyses of spray residues indicate that the capacity of the mist blower used in Indiana—8,000 cubic feet of air a minute at 125 miles an hour—was not adequate for proper distribution of the spray throughout large apple trees. Deposits in the extreme tops and in the centers of the trees were only one-tenth as great as those in the outer and lower parts of the trees on the side from which they were sprayed. The variation in deposits in comparable parts of trees sprayed with a conventional machine equipped with hand guns was only one-third as great.

Methoxychlor Promising Against Orchard Pests and Japanese Beetle

Methoxychlor promises to be useful in controlling the codling moth and the apple maggot on apples, the plum curculio on apples and stone fruits, the Japanese beetle on corn and other crops, and the grape berry moth and the cherry fruit fly. Because of its low toxicity to human beings, it can be used closer to harvest than many other materials and, under certain conditions, where other insecticides might be objectionable.

In laboratory tests against the Japanese beetle, 2 pounds to 100 gallons of a 50-percent methoxychlor wettable powder was as effective as DDT of the same strength. In field tests, two applications of this formulation gave nearly complete protection to various ornamental

trees and shrubs, and a single application protected ripening peaches for 12 days. Three applications of 30 pounds of a 5-percent dust an acre at 4-day intervals destroyed an infestation on young bearing peach trees and prevented establishment of an infestation on sweet corn. Two applications 5 days apart of an emulsion spray at the rate of 1.5 pounds of toxicant an acre protected hybrid corn against beetle damage.

More effective than DDT against the plum curculio, methoxychlor is especially promising for protecting apples against this pest. Inclusion of 3 pounds of a 50-percent methoxychlor wettable powder to 100 gallons in the calyx and first two cover sprays held curculio injury to a very low level under conditions of light infestation in Indiana. Elsewhere methoxychlor was equally promising for the purpose, especially when used in combination with lead arsenate. The performance of methoxychlor in controlling the plum curculio on peaches has been erratic.

Earlier promising results in controlling light infestations of the codling moth and the cherry fruit fly with methoxychlor were confirmed in the Pacific Northwest. In small-plot field tests in Washington methoxychlor controlled the codling moth as well as did DDT. It also gave a high degree of control of the cherry fruit fly in Oregon. Against this fruit fly a wettable-powder spray was slightly superior to a dust, but an emulsion was ineffective.

Additional studies pointed to the possible value of methoxychlor for control of the apple maggot and grape berry moth. In New York five applications gave excellent control of the apple maggot. In 1949 about 95 percent of the apples in the experimental orchard were infested; in 1950, following the treatment, the infestation was reduced to less than 6 percent. In Ohio methoxychlor alone (2 pounds of 50-percent wettable) has consistently given control of the grape berry moth nearly equivalent to that of the standard schedule of DDT alone (1.5 pounds of 50-percent wettable). Neither material used alone is quite as effective as when it is in combination with parathion.

New Insect Vectors of Virus Diseases of Stone Fruit Found

Experiments at Logan, Utah, indicate that the black cherry aphid can transmit the virus, or viruses, responsible for wilt, or decline disease, of sweet and sour cherry trees growing on mahaleb rootstocks. Field observations indicate that *Colladonus geminatus* (Van Duzee) is still the most important vector in Washington orchards. However, three additional species of leafhoppers capable of serving as carriers of western X disease—*Scaphytopius acutus* (Say), *Fieberiella florii* (Stal), and *Keonolla confluens* (Uhler)—have been discovered by cooperating Washington State entomologists of the Tree Fruits Branch Experiment Station at Wenatchee. Leafhopper transmission of western X disease from infected cherry trees to healthy peach trees was demonstrated by the Washington State entomologists and confirmed by Bureau workers in Utah. Leafhopper transmission of western X disease from infected chokecherry to healthy peach trees was also demonstrated in Utah.

The important results of the vector studies may be attributed largely to the close cooperation of the Washington, Oregon, and Utah Agri-

cultural Experiment Stations, the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Bureau of Entomology and Plant Quarantine. The Bureau's contribution to the work was financed with funds made available through the Research and Marketing Act.

Two Species of Aphids Determined as Vectors of Strawberry Virus Diseases

Many specimens of aphids suspected of being vectors of certain virus diseases of strawberries have been submitted for identification from widely separated strawberry-growing areas of the United States. These virus diseases, that result in a yellowing or stunting of the plants, are under investigation by the Bureau of Plant Industry, Soils, and Agricultural Engineering and several State agricultural experiment stations. Originally only one aphid species was thought to be responsible. Recent studies by the Bureau's taxonomists have established the involvement of two distinct species of the genus *Capitophorus*, one of them still undescribed. Both species are found on the west coast and in Wisconsin. Only the undescribed form has been represented in collections from strawberries in the Eastern States.

Materials for Controlling Most Pecan Insects Now Available

Pecan growers can reduce infestations of the pecan nut casebearer with suitable insecticides applied at various times during the season, according to the results of recent tests. DDT, which has become the most commonly recommended insecticide for this insect, continued to give good results both in experimental plots and in applications made by pecan growers. Tests in Florida and Texas indicate that more latitude in the timing of sprays may be permissible when DDT is used than with the older treatments.

In Florida five summer applications of DDT or parathion at 3-week intervals, the last on September 11, eliminated overwintering nut casebearers in all but one plot, which was sprayed with parathion and showed a high reduction. Single spray applications of DDT or parathion late in the dormant period reduced twig infestations caused by overwintered larvae. In tests of single, well-timed applications for control of first-generation larvae, DDT, parathion, lindane, and ethyl *p*-nitrophenyl thiobenzene phosphonate (EPN), each in combination with oil and bordeaux mixture, were either equal or superior in effectiveness to nicotine sulfate with oil. DDT in bordeaux mixture without oil also was outstanding. Mist-blower spray applications of parathion, in combination with oil and ziram, indicated that this method has definite possibilities for control of the nut casebearer.

In Texas one or two applications of DDT, toxaphene, parathion, and EPN for control of first-generation larvae gave high yields of nuts, despite a heavy initial infestation. The best yields were obtained in plots that received two applications of DDT with summer oil or two applications of parathion.

Some progress has been made in developing spray programs for the simultaneous control of all the major insects and diseases that attack pecan trees. Effective materials for controlling most of the insect

pests are now available. The lack of a practical means of controlling the hickory shuckworm is still a major obstacle to the satisfactory development of a complete spray program.

Plum Curculio Yields to Various Materials

Several of the newer organic insecticides gave good control of the plum curculio without injuring the trees or fruit in tests on apples and stone fruits from New York south to and including Georgia and west to eastern Illinois. Included among the materials were parathion, ethyl *p*-nitrophenyl thiobenzene phosphonate (EPN), chlordane, a 1 to 2 mixture of 1,1-bis(*p*-chlorophenyl)-2-nitropropane and 1,1-bis(*p*-chlorophenyl)-2-nitrobutane (Dilan), aldrin, dieldrin, and methoxychlor. They were generally more effective against the plum curculio, especially on stone fruits, than lead arsenate, the material depended on for many years. No one material was markedly superior to all others in all respects.

In a large-plot experiment in a Georgia peach orchard, either four applications of parathion or chlordane or two applications of benzene hexachloride followed by two applications of lead arsenate were highly and about equally effective against the plum curculio. The treatments were markedly more effective than the regular three-application schedule of lead arsenate. A five-application schedule of parathion, the last one 2 weeks before harvest, gave almost complete control and was superior to other treatments. Both the total number of peaches that dropped and the percentage of dropped fruit that was wormy were much greater when lead arsenate was used alone than when parathion, chlordane, or a combination of benzene hexachloride with lead arsenate was used. In a single-tree plot experiment on peaches in Georgia, parathion, aldrin, dieldrin, and a split program of parathion and EPN gave outstanding control. Dilan and 2,2-bis(*p*-fluorophenyl)1,1,1-trichloroethane (DFDT) did not give satisfactory control.

In heavily infested peach field plots in West Virginia, parathion, aldrin, and dieldrin were superior to lead arsenate, lindane, benzene hexachloride, and low-strength EPN in preventing curculio injury. In Indiana, under conditions of light infestation, parathion, EPN, Dilan, dieldrin, methoxychlor, lindane, chlordane, aldrin, and benzene hexachloride were about equally effective in holding down curculio injury. In a large test in Illinois parathion spray held curculio injury to 1 percent, while benzene hexachloride dust applied by the grower allowed injury by the curculio to 41 percent of the fruit in one nearby block and 12 percent in another.

Of the insecticides tested on peaches in Indiana, only benzene hexachloride and, to a lesser degree, lindane gave the fruit, either fresh or processed, an off-flavor. In Georgia only benzene hexachloride used in a full schedule, the last application a month before harvest, caused off-flavor in fresh peaches. When the peaches were canned, however, off-flavor was noted in those that had received either benzene hexachloride or lindane in a full schedule and in those that had received benzene hexachloride 74 days before harvest.

The spray residue on harvested peaches was comparatively low in all the experiments, except where methoxychlor or DDT was used

in four applications in Georgia. Parathion residues were well below 1 part per million, even when this material was used in five applications, the last one 2 weeks before harvest.

In southern Indiana injury by plum curculio was held to a low level on lightly infested apples by application of a calyx and two cover sprays containing any one of the following materials to 100 gallons: Methoxychlor (50 percent), 3 pounds; dieldrin (25 percent), 2 pounds; aldrin (25 percent), 2 pounds; lead arsenate, 3 pounds; DDT (50 percent), 2 pounds, plus lead arsenate, 2 pounds; lindane (25 percent), 1.5 pounds, plus lead arsenate, 2 pounds; parathion (15 percent), 1.5 pounds; and EPN (27 percent), 0.75 pound.

New Insecticides Valuable in Control of Oriental Fruit Moth

DDT and parathion have given excellent results against the oriental fruit moth. In eastern Illinois a five-application spray schedule of parathion held injury to peaches to less than 1 percent, as compared to 4 and 14 percent in two blocks nearby that were dusted with benzene hexachloride. In New Jersey both parathion and DDT gave significant reductions in injury in orchards where they were used as preharvest applications. EPN also gave excellent results.

In other field tests in New Jersey three applications of parathion during the period of first-brood moth activity practically eliminated the adult moths and prevented injury to peach twigs in the treated area through most of the period when the larvae normally work in them. Although no additional sprays were applied, fruit injury at harvest was lower than in orchards nearby where no control measures for this insect were used. The results point to the possible value of a first-brood suppression program, especially in orchards not near a source of reinfestation.

Parathion residues weathered rapidly to below 0.5 p. p. m. in all tests in New Jersey and Ohio. DDT residues were generally above 5 p. p. m. if used in two or three preharvest applications in the same areas. Although residues from sprays applied by growers are usually less than those from experimental applications, it may be impossible to use enough DDT to control the oriental fruit moth without excessive harvest residue. Residues of EPN were slightly more persistent than those of parathion.

Parasites Combine With Insecticides To Control Oriental Fruit Moth

A combination of parasites and insecticides gave excellent results against the oriental fruit moth in New Jersey. Under conditions in which 24 percent of the fruit was injured at harvest in the absence of control measures, the proportion of injured fruit was reduced 62 percent by the liberation of parasites and from 84 to 90 percent by the combined use of parasites and insecticides, either parathion or DDT. Mass liberations of parasites alone generally reduce fruit injury by about 50 percent.

Use of the new insecticides has not yet seriously affected parasites of the oriental fruit moth, studies in New Jersey indicate. The parasitization following moderate to heavy exposures to the new organic insecticides is very nearly as high as that before the insecticides were used. Heavy parasitization of first- and second-brood larvae in Ohio

also is believed to have been responsible for a reduction in injuries by the oriental fruit moth in commercial peach orchards. *Macrocentrus ancylivorus* Rohw. was the principal parasite, although five other species were involved.

Ladybird Beetles Withstand DDT Sprays

Ladybird beetles, predators of mites on apples in the Yakima, Wash., area, recovered sufficiently after two DDT sprays to effect adequate control of the mites during the latter part of the season. The study showed for the first time that beneficial insects are effective in controlling mites after spraying with DDT.

Progress Made Toward Eradication of Hall Scale

Progress toward the eradication of Hall scale from the limited area in California where it has been found continued. No living scale was found during the inspection of an isolated infestation at Oroville. As this infestation has now received three fumigations, it has been dropped from the fumigation schedule, but will be reinspected from time to time. All trees known to have scale on them have been removed from the infested area at Davis. In the main area near Chico intensive inspection revealed the presence of scale on four additional properties, involving about 700 trees. All the properties are within the area known to be infested. Severe weather in the winter of 1950–51 and unusually early development of the trees in the spring interfered with the fumigation program. Approximately 4,000 trees were fumigated, 1,280 of them for the third and last time unless live scales reappear on them. The rest received their first or second fumigation. About 2,000 trees remained untreated. All trees left on the treatment schedule were sprayed to retard spread of scales.

Frost in Texas Groves Makes Control Measures Against Mexican Fruit Fly Unnecessary

Severe freezing weather for several days late in January 1951 seriously curtailed the production of citrus fruit in Texas groves. This was the second consecutive year that the groves had been severely frozen. Most of the fruit remaining on the trees was damaged to such an extent that it could not be shipped as fresh fruit. The trees themselves suffered severely. A large number of young trees not properly banked were killed outright. Most of the older trees, weakened by previous cold weather, were either killed outright or were so severely damaged that many of them will be removed. Low temperatures struck just as control activities against the Mexican fruit fly were getting well under way. Inspections throughout the earlier part of the year had indicated that the fruit flies were beginning to build up and that the annual migration from Mexico was in progress. No infested fruit had been found and no sterilization activities were under way at the time of the freeze. The trees that remained in the groves made rather slow progress toward recovery, owing to an unusual drought. By the beginning of summer indications were that many old trees and a large number of young banked trees had survived, with prospects for a small fruit crop.

Quicker Vapor-Heat Sterilization Treatment Under Test

A modification in the vapor-heat treatment used in certifying certain fruits from areas infested with the Mexican fruit fly employs a run-up to higher temperatures without the holding period previously required. Out of more than 4 million immature flies in test fruit there was no survival after fruit temperature exceeded 117° F. Manila mangoes and three varieties of grapefruit were sterilized to 117° F. without detectable change in flavor or measurable loss in ascorbic acid.

TRUCK-CROP AND GARDEN INSECTS

Control Campaign Against Sweetpotato Weevil Continued

Growers and packers benefit from control of sweetpotato weevil

Utilizing the treatment for control of sweetpotato weevils developed last year, in cooperation with the Louisiana Department of Agriculture and Immigration, storage operators in Louisiana dusted with DDT more than 1.5 million bushels of sweetpotatoes. The sweetpotatoes were washed to remove any hazardous residue before they were marketed. The new treatment proved practical and economical. By destroying the weevils it prevented the severe losses that occur in infested sweetpotatoes during storage. Now that sweetpotatoes in storage are no longer a source of infestation to nearby plantings and the April 1 storage clean-up deadline has been extended indefinitely, sweetpotatoes are being marketed in a much more orderly fashion.

The DDT treatment was of particular benefit to growers and packers in the heavy producing areas of southwestern Louisiana. In 1946 as high as 20 percent of the sweetpotato crop there was weevil-infested. This year DDT treatments and sanitary practices reduced infestations to below 3 percent.

The treatment also assures to the growers an adequate supply of weevil-free planting stock. Before it was developed the growers in heavy producing areas required such large quantities of planting stock that they were unable to obtain enough weevil-free certified seed sweetpotatoes. To fill this need in the Louisiana control areas, more than 300,000 bushels of seed sweetpotatoes were dusted with DDT at the time of storage in the fall of 1950.

Extensive farm areas freed of sweetpotato weevil

More than 1,700 farms were rid of sweetpotato weevils as a result of eradication and control measures carried on during the year in cooperation with the States of Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. This farm land included all properties in three counties. Approximately 12,000 farms have been freed from weevil infestation since the cooperative eradication began in 1937. Thirty counties once infested are now free from the weevil.

Educational campaign stimulates control efforts by growers

An educational campaign like that used effectively in 1950 in Louisiana to reduce losses from the sweetpotato weevil and prevent further spread of the pest was extended to Georgia, Florida, and South Caro-

lina. Recent spread, especially in Georgia, was creating a serious threat to commercial production in the Southeastern States. With the assistance of the Extension Service and the Farm Bureau, 171 meetings were held in 24 counties in the 3 States, with an attendance of 6,612, representing farmer groups, instructors in vocational agriculture, GI farm trainees, agriculture classes, and civic clubs. The program provided instruction and demonstrations in weevil eradication, control practices, and methods of preventing spread. The educational program was also extended to northeastern Texas, where infestations were recently found in areas of heavy sweetpotato production. The program aroused great interest among sweetpotato growers. Grower participation in the cooperative weevil-control program immediately increased.

Alternate insecticide nontoxic to humans developed for control of sweetpotato weevil

A third insecticidal dust that may serve as an alternate to DDT or methoxychlor, and is rapid enough in toxic action to prevent oviposition by sweetpotato weevils on sweetpotatoes in storage, consists of 0.8 percent of piperonyl butoxide and 0.04 percent of pyrethrins in a suitable diluent. Adults were killed 91 days after application. Oviposition in dusted sweetpotatoes was prevented for more than 2 months in preliminary trials. This dust mixture is nontoxic to man and animals, thus presenting no problem of toxic residues.

Systemic Insecticides Make Pea Plants Toxic to Pea Aphid

Treating pea seeds or pea plants with either of two systemic insecticides, octamethyl pyrophosphoramide or a trialkyl thiophosphate, makes the plants toxic to the pea aphid, according to results of preliminary experiments in the greenhouse and in the field at Madison, Wis.

In the greenhouse octamethyl pyrophosphoramide was toxic to pea aphids placed manually on pea plants after the plants were sprayed with a solution of the chemical. Plants growing from seeds planted in soil soaked with the solution just before planting, and those growing from seeds treated directly with the solution before planting, also showed toxicity to aphids.

Pea plants sprayed in the field with solutions of octamethyl pyrophosphoramide were highly toxic to the pea aphid. The solutions were applied with a mist blower at rates of 0.25 and 0.5 pound of the chemical an acre in 10 gallons of water. Treatment of pea seeds with either octamethyl pyrophosphoramide or a trialkyl thiophosphate controlled the pea aphid on the resulting plants for approximately 6 weeks in a season when the infestation was very slow in developing. Best results were obtained when solutions of the chemicals were applied to pea seeds at the rate of 500 grams, or approximately 1 pound, to 4 bushels of seed, a quantity sufficient to plant 1 acre. Plants developing from treated seeds, as well as those that were sprayed, showed no foliage injury.

The experiments were conducted in cooperation with the Wisconsin Agricultural Experiment Station.

Octamethyl pyrophosphoramide and a trialkyl thiophosphate are retained within treated plants for some time. Consequently, they

should not be applied commercially to any vegetable crop to be used as food until more information is available as to the possible health hazard incurred.

Red Spiders Succumb to Systemic Insecticide

Aerosols, sprays, or drenches containing the systemic insecticide octamethyl pyrophosphoramide (OMPA) have proved very effective against red spider mites on greenhouse-grown roses, ageratum, carnation, dahlia, and chrysanthemum. This was true even with the strains of mites that are resistant to other insecticides. Preparations containing OMPA were effective also against aphids infesting these crops, but, in the same dosages, they were not toxic to such other common greenhouse pests as thrips, whiteflies, mealybugs, or several species of chewing insects. These results are of immediate importance to greenhouse operators, who are currently faced with the problem of combating resistant red spider mites on ornamental plants. Certain strains of the mites have developed a resistance to aerosols containing parathion, hexaethyl tetraphosphate, tetraethyl pyrophosphate, tetraethyl dithiopyrophosphate, and some other insecticides that formerly gave effective control.

Research, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, showed that octamethyl pyrophosphoramide is absorbed through the leaves, stems, or roots of treated plants, depending on the method of application. The absorbed material enters the sap stream of the plant and moves up the stem from the roots or lower leaves to the upper leaves and buds. Here it becomes sufficiently concentrated in a few days after application to be toxic to red spider mites and aphids feeding on the sap in those parts. It does not move down the stem from upper leaves to lower ones or from the leaves to the roots.

In experiments in the Bureau's greenhouses at Beltsville, Md., and in commercial greenhouses, aerosols containing either 5 percent or 10 percent of octamethyl pyrophosphoramide, with methyl chloride as the propellent gas, gave excellent results against mites and aphids on roses. The dosage was at the rate of 1 pound to 50,000 cubic feet of either the 5-percent or the 10-percent formulation or at the rate of 1 pound to 100,000 cubic feet of the 10-percent formulation. No serious injury resulted to five commonly grown varieties of roses. Best results were obtained, however, when the insecticide was applied to young and vigorously growing plants, because octamethyl pyrophosphoramide is more readily absorbed by the younger foliage.

Octamethyl pyrophosphoramide was also effective against spider mites and aphids on ageratum, carnation, rose, dahlia, and chrysanthemum when applied lightly as a mist spray to the tops of the plants in greenhouses. The spray consisted of a 1 to 1,000 water dilution of the technical material containing 60 to 70 percent of the active ingredient, with a small quantity of wetting agent. Eight weekly applications were tolerated without injury by Better Times and Briarcliffe roses, but they caused slight to moderate yellowing of the older leaves on Starlight, Golden Rapture, and Cavalier roses.

A single drench of octamethyl pyrophosphoramide applied to the soil in flowerpots containing roses or lilies was taken up by the roots

of the plants, making the plants toxic to spider mites for about 5 weeks. One teaspoonful of the chemical containing 60 to 70 percent of the active ingredient to 3 gallons of water was applied to the soil at the rate of approximately 3 fluid ounces in a 6-inch pot. Dosages above this level cause brown necrotic spots at the margins of newly expanded rose leaves. Less effective results were obtained in applying the systemic insecticide to the soil of rose beds, apparently because heavy watering flushed the chemical out of the soil before it was taken up by the roots.

Here again additional information on the health hazard involved must be developed before any conclusions can be reached as to the suitability of octamethyl pyrophosphoramide for use on greenhouse-grown vegetable plants.

Airplane Sprays for Control of Pea Aphid Studied

The principal causes for the unequal distribution of sprays from airplanes as ordinarily used to control the pea aphid were determined in experiments at Forest Grove, Oreg. The experiments were conducted with a Stearman biplane, with a 30-foot wingspread, equipped with a 30-foot underwing spray boom having nozzles 4 inches apart. In flights about 2 feet above the soil surface, with the wheels touching the pea vines, the spray deposits were effective against the pea aphid over a swath about 50 feet wide. The spray was deposited unevenly over the 50-foot swath, with a peak of the deposit 2 to 3 feet to the left of the center of flight and corresponding peaks near the path of each wingtip. A dyed spray was used in the experiments. Photographs of the dyed spray taken during the applications showed that the peaks of spray deposit were caused by the whirl, or vortex, of air set up by the propeller and by each wingtip in its passage through the air. It became obvious, therefore, that some of the nozzles should be closed to obtain an even distribution of the spray.

In an attempt to determine which nozzle to close in order to obtain an even distribution of spray throughout the swath, separate flights were made with all the nozzles closed except groups of three, each group representing a 1-foot segment of the boom. Flights were repeated for each 1-foot section of the boom. The results thus obtained showed that sections of the spray boom 9 to 15 feet from the center on each side deposited the spray in approximately the same position, which meant that the spray ejected by several feet of spray boom on each end was unnecessary for a maximum swath width. The tests also showed that the whirl of air from the propeller picked up the spray from a short distance to the right of the center of flight and deposited it several feet to the left, causing a peak of spray deposit on the swath in that zone. Continued tests are necessary to determine how to compensate for this phenomenon.

Similar tests were made with the airplane flying at 10 feet above the soil surface. They showed that the spray-deposit pattern at this height was approximately the same as at the 2-foot elevation, except that the spray was deposited in a wider swath.

Knowledge gained in the course of these experiments has provided criteria and fundamental data for determining satisfactory nozzle spacings, minimum spray boom lengths, and effective swath width.

The tests also provide a theoretical basis for improvements in both airplane sprayer design and airplane duster development.

The work was done in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, the agricultural experiment stations of Oregon, Washington, and Idaho, and the pea canners. It was financed largely with funds authorized under the Research and Marketing Act and with funds contributed by the canners.

Lindane in Transplanting Water Protects Tobacco Seedlings From Wireworm Injury

Lindane protects small tobacco seedlings against wireworm injury when added to the transplanting water, according to the results of experiments conducted in South Carolina. The material was used at the rate of 0.25 ounce of 25-percent lindane wettable powder in 50 gallons of the water used for transplanting. Using the same method of application, 4 to 8 ounces of 50-percent chlordane wettable powder, or 4 to 6 ounces of 15-percent parathion wettable powder, gave fair to good protection of the plants against wireworms, but these materials were less effective than lindane and more expensive. A dosage of 8 ounces of 15-percent parathion wettable powder, or an equal quantity of 50-percent TDE wettable powder, caused the rotting of many of the treated tobacco plants and the TDE gave little protection against wireworms. The transplanting water was applied at the rate of 300 to 400 gallons an acre.

The experiments were conducted in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and the South Carolina Agricultural Experiment Station.

Toxaphene May Affect Odor of Flue-Cured Tobacco

Under some conditions the use of toxaphene on flue-cured tobacco to combat hornworms, grasshoppers, cutworms, and the suckfly may impart an objectionable odor to the cured tobacco. This effect was particularly noticeable when toxaphene was applied to the tobacco crop in heavy dosages after the plants were approximately 2 feet high in experiments in South Carolina. The experiments indicated that the objectionable odor was more likely to occur when toxaphene was applied in an emulsion spray, owing possibly to the effect of the solvent, or emulsifier, used in preparing the emulsion.

The odor tests were made in cooperation with the research laboratory of a tobacco company. The test samples were tobacco leaves that had been carried through the regular commercial processes of curing, bulking, grading, redrying, stripping, accelerated aging, and manufacturing. The odor of toxaphene could be detected to some extent in all of the treated samples when the cured tobacco was made into cigarettes and smoked or was heated.

The experiments were conducted in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and the South Carolina Agricultural Experiment Station.

Effect of Insecticides in Soil on Certain Crops Studied

The widespread use of insecticides on crop foliage has created the problem of determining the effects of their presence in the soil on the

growth of various crops. Experiments were begun at Florence, S. C., in the spring of 1947, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and the South Carolina Agricultural Experiment Station, to determine the effects of soil applications of three insecticides on five crops grown in a 3-year rotation. Results of the first 3 years of the experiments have now been analyzed.

The same soil treatments and the same crop successions were used in each of three randomized-block experiments. Each experiment, however, was started with a different crop—tobacco, cotton, or cowpeas. In this manner, tests were made on all crops each year. Tobacco was followed by a mixture of oats and Austrian winter peas, by cowpeas the second spring, by rye the second fall, by cotton the third spring, by rye the third fall, by tobacco the fourth spring, and by oats with Austrian winter peas the fourth fall, the same crop cycle being followed in each plot.

Each of the 3 experiments involved the application of 10 and 20 pounds of DDT an acre each spring, following dosages of 40 and 100 pounds in 1947 only. Cotton did not seem to be affected by any of the treatments except the 100-pound dosage applied in 1947. This dosage appeared to cause some chlorine injury, characterized by glossy brittle leaves, in 1947 and to affect the yield and burning quality of the 1949 tobacco crop.

All except the 40-pound dosage of DDT affected cowpeas to some extent. The effects were not apparent until 1948. The 100-pound dosage reduced the yield of cowpeas in the hull in 1948 and reduced the stand of the plants in 1948 and 1949. The 40-pound dosage did not significantly affect the cowpeas in any year, but the yield of hay and peas in the hull was lower than that from the untreated check in 1948. Three annual applications of 10 or 20 pounds an acre reduced the stand and growth of the cowpea plants. The 100-pound dosage seemed to retard the growth of a mixture of oats and Austrian winter peas. Rye was susceptible to injury by DDT, and even a total of 30 pounds applied over a 3-year period reduced growth under some conditions.

Toxaphene at 20 pounds an acre annually was less injurious to the three crops than DDT at the same dosage.

Each experiment also included tests with technical benzene hexachloride, containing 12 percent of the gamma isomer, applied annually at 16.7 pounds an acre, and at 12.5 pounds with 2.5 pounds of DDT. In 1947 benzene hexachloride was applied also at 83.3 pounds an acre, and at 50 pounds with 10 pounds of DDT. All the treatments affected the flavor of the tobacco in 1947, the only year in which the flavor was checked. The 50- and 83.3-pound dosages reduced the stand of a root-knot-resistant variety of tobacco in 1947, when the plants were transplanted shortly after the insecticides had been applied. In 1948 and 1949, when a root-knot-susceptible variety was grown, all dosages gave some control of the root knot nematode. Also in 1949 a slightly higher yield was obtained from the plots that had received the two heaviest dosages in 1947. All dosages reduced the 1947 stand of cotton planted shortly after the insecticides had been applied, but in subsequent years none of the treatments harmed the cotton. The benzene hexachloride did not seem to injure rye so much as did DDT,

and for some unknown reason it appeared to increase the yield of cowpeas in the hull. Benzene hexachloride, like DDT, did not injure rye following cotton as much as it did rye following cowpeas. The heaviest dosage of benzene hexachloride imparted a reddish color to rye and oat plants, especially during the 1948–49 season.

All insecticides were incorporated in the soil in order to test in as short a time as possible dosages comparable to residues that might eventually build up in practice. However, it is doubtful whether the accumulations that would result from normal applications of the insecticides to foliage of field crops would be comparable to the high dosages tested. Most insect pests are controlled by foliage applications of insecticides, some of which may be removed with run-off water or blown away by winds and therefore never become incorporated in the soil.

It appears that the effects of DDT and benzene hexachloride on the crops studied were dependent on a number of factors, including rainfall and other seasonal conditions, the crop, the soil type, the insecticide, the dosage, the number of years the insecticide had been in the soil, and the crop rotation.

New Insecticides Control Leaf Miners

Progress was made in the development of methods of controlling several species of dipterous leaf miners, often referred to as serpentine leaf miners, which for the last several years have damaged tomatoes, sugar beets, peppers, lettuce, and cantaloups in California, Arizona, Texas, and Florida. Promising results have been obtained with parathion, toxaphene, chlordane, dieldrin, and aldrin, although no entirely satisfactory control for the pests has been developed. DDT has not been very toxic to the leaf miners and in some tests reduced their insect parasites, resulting eventually in more leaf miners than when no insecticides had been used. Toxaphene dusts and sprays have generally given good control on lettuce and sugar beets but cannot be used on cantaloups because of insecticide injury. Chlordane in dusts and in sweetened sprays has been effective in controlling the insect on cantaloups in Arizona. Parathion and dieldrin have given good control on cantaloups in Arizona and on tomatoes in California. In some of the experiments parathion has been the most effective insecticide, but it must be applied more often than the other materials. Chlordane, toxaphene, and dieldrin kill the larvae of the insect within the leaf tissues.

Experiments are being continued to determine the best insecticides for the different crops and how they can be most effectively applied. For each crop greatest emphasis is being given to materials which, in addition to controlling the leaf miners, will be useful in controlling other insects that damage the crop. On cantaloups, for example, parathion has given promising results in controlling not only the leaf miners but also thrips, red spider mites, and the beet leafhopper, whereas dieldrin is not effective against the red spider mites. On tomatoes, dieldrin mixed with sulfur and talc shows promise for the control of leaf miners, the tomato fruitworm, and the tomato russet mite. The mixture cannot be used on cantaloups because sulfur sometimes injures this crop.

Control of Onion Thrips Improved

Experiments in cooperation with the Idaho Agricultural Experiment Station showed that dust mixtures or sprays containing DDT, toxaphene, parathion, and chlordane were about equally effective and gave excellent control of the onion thrips on commercially grown bulb onions in Idaho. The new insecticides, now used extensively by growers, are a marked improvement over the nicotine-sulfate and tartar-emetic sprays formerly used. Preliminary tests in Idaho disclosed that a newly introduced insecticide—an ethyl *p*-nitrophenyl thionobenzene phosphate—has potential value for the control of the onion thrips when used in a spray. In experiments in California dust mixtures containing chlordane, aldrin, parathion, toxaphene, and lindane were equal to or slightly superior to DDT dusts in the control of the onion thrips and gave increased yields of bulb onions in comparison with DDT dust.

Aphids Transmit Virus of Dahlia Mosaic

At least five species of aphids transmit the virus of dahlia mosaic that causes the decline of many commercial varieties of dahlias, according to results of experiments at Beltsville, Md., in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering. The green peach aphid and the potato aphid were found to be the species most capable of transmitting the virus. The bean aphid, melon aphid, and foxglove aphid were slightly less capable. The aphids transmitted the virus in a nonpersistent manner; that is, they became infectious by feeding for a minute on a diseased plant, after which they were able to infect a high percentage of the healthy plants they fed on during the next 2 hours. By the end of that period they had lost their ability to transmit the virus. Aphids starved before feeding on diseased plants were more efficacious as vectors of the dahlia mosaic virus than aphids fed normally. Dahlia mosaic was transmitted by virus-carrying aphids to zinnia and to three ornamental species of plants closely related to dahlia. Dahlia mosaic symptoms developed more quickly in zinnia than in dahlia or its related species.

Zineb Fungicide Has Incidental Insecticidal Effect on Pickleworm and Melonworm

Experiments on the control of the pickleworm and melonworm in South Carolina showed that the fungicide zineb is toxic to these insects when it is applied primarily for the control of plant diseases on cucumbers.

Cucumbers in commercial fields and experimental plots where zineb was applied were less heavily infested with the pickleworm and melonworm than those in plots where no insecticide was used or where fungicides other than zineb were applied. Application of zineb to cucumbers in dusts or sprays, at the dosages ordinarily used to combat plant diseases, killed approximately 50 percent of the partly grown pickleworms in laboratory and small-scale field tests. The fungicide did not kill the full-grown pickleworms and was only partially effective in protecting the cucumber fruits from infestation.

Zineb alone is not an adequate remedy for the pickleworm and melonworm. Its insecticidal action, however, does contribute to the effectiveness of such insecticides as lindane, parathion, and DDT against them.

These experiments were conducted in cooperation with the South Carolina Agricultural Experiment Station.

Importation of European Insect Parasites

Importations of foreign parasites for rearing and colonization in the United States continued at about the same rate as last year.

Shipments of European corn borer parasites from France and Italy consisted of 40,500 field-collected corn borer larvae, of which 4,635 were parasitized with *Campoplex alkae* E. and S., 2,183 with *Microgaster tibialis* Nees, and an undetermined number with *Apanteles thompsoni* Lyle.

Fewer imported parasites of the European chafer were available this year for colonization in the infested area in New York. Shipments from the rearing laboratory in France included 124 puparia and 125 adults of *Dexilla rustica* (F.) and 111 adults of *Microphthalma europea* Egger.

Small consignments of *Microctonus aethiops* (Nees.) and *Campogaster exigua* (Meig.), parasites of the sweetclover weevil, were again forwarded from France to the North Dakota Agricultural Experiment Station.

Four shipments, including six large boxes of European elm and fig scale material, were shipped from France to the California Agricultural Experiment Station. The material contained several species of parasites of the scales.

CHEMISTRY OF INSECTICIDES

Allethrin Adopted for Use in Aerosols

Allethrin has been approved for use in household aerosols. One of the most effective of the synthesized pyrethrinlike esters, this insecticide is being produced commercially by two companies, using the method of synthesis developed by Bureau chemists.

The Army has adopted allethrin as an alternate for pyrethrum extract in its aerosol bombs, thus making this country independent of imported supplies of pyrethrum, which was very difficult to obtain during World War II. The present selling price of allethrin is slightly lower than that of pyrethrum.

Satisfactory analytical methods for the assay of technical allethrin and insecticides containing it have been difficult to devise. A method based on hydrogenolysis of allethrin to yield dihydrochrysanthemum monocarboxylic acid, which is then titrated, was developed in the Bureau's chemical laboratories. A cooperative study of this and several other proposed methods is under way in Government and industry laboratories. The current procurement by the Army of allethrin for aerosols makes the study particularly important.

A number of pyrethrinlike esters differing from allethrin in various details of structure of the acid and cyclopentolone portions of the

molecule have been synthesized and submitted for testing against insects.

Respiratory Devices Give Satisfactory Protection Against Organic Phosphates and Chlorinated Insecticides

The cooperative program for the development of respiratory equipment to protect operators applying insecticide vapors, mists, and dusts was continued by Federal agencies and manufacturers. Under the leadership of Bureau chemists, respirator cartridges and filters and gas-mask canisters were developed that give satisfactory protection against parathion, tetraethyl pyrophosphate, tetraethyl dithiopyrophosphate, ethyl *p*-nitrophenyl benzene thionophosphate, lindane, aldrin, and dieldrin. It was necessary to incorporate a special fume filter with the respirator cartridges for use against mists and sprays containing tetraethyl pyrophosphate. Activated charcoal was used in the cartridges for protection against the chlorinated compounds. Gas-mask canisters of the type used for organic vapors, acid gases, fumes, and dusts are effective against all these insecticides.

Method for Determining Particle Size of Aerosol Devised

A mechanical method was developed for collecting a sample of an aerosol on a microscope slide. It provides the insecticide industry with a uniform method of determining the average particle size of an aerosol.

Systemic Action of Octamethyl Pyrophosphoramide Studied

Studies were made on the absorption and movement of octamethyl pyrophosphoramide in several species of plants. Octamethyl pyrophosphoramide is one of the chemicals receiving attention because of their systemic action, whereby they are absorbed by plants in sufficient quantities to kill insects feeding on the plants. The results of this year's experiments indicate that until more information is available on the health hazard involved, octamethyl pyrophosphoramide should not be used on food crops.

Studies were made of the absorption and movement of octamethyl pyrophosphoramide in the plant. Experiments in which radioactive phosphorus was used as a tracer indicated that the insecticide tends to move into the young, growing parts of the plant, where it is most rapidly absorbed. The results were confirmed by chemical studies using a sensitive colorimetric method of analysis developed by Bureau chemists.

Experiments on the rate of penetration of octamethyl pyrophosphoramide into leaf tissue showed that under the experimental conditions about 90 percent of the amount applied to the foliage could no longer be recovered by washing the leaves of bean plants after 48 hours and rose leaves after 72 hours.

In a study of the persistence of this compound in chrysanthemum plants, 4-inch cuttings were placed in an aqueous solution and allowed to take up the insecticide. The cuttings were then planted and allowed to grow for 60 days to a height of 3 feet. At the end of that time traces of octamethyl pyrophosphoramide still could be detected in the growing tips of the plants.

In experiments with peas, seeds were soaked in an aqueous solution of octamethyl pyrophosphoramide before planting. When the plants grown from these seeds were analyzed after 2½ months, at the usual stage of growth for harvesting peas, the insecticide could be detected in peas, pods, and vines.

Tests utilizing the analytical method which measures the degree of inhibition of the enzyme cholinesterase showed that octamethyl pyrophosphoramide is converted in the plant to some material which has an inhibitory action many times greater than that of the original insecticide.

A number of other organic phosphorus compounds were submitted for preliminary testing. Several showed pronounced systemic action, among them the oxygen analog of parathion, although parathion itself does not have this property.

Specifications for Aerosol Formulations and Equipment Prepared

Specifications were prepared for a pyrethrin-containing low-pressure aerosol formulation and for a formulation containing allethrin as an alternate for the pyrethrins.

Tetraethyl dithiopyrophosphate in aerosols for use against insect pests in greenhouses was approved. The quality of the commercial grade of this insecticide has been improved to eliminate material insoluble in methyl chloride. Aging tests showed that tetraethyl dithiopyrophosphate has less action on aerosol containers than parathion or tetraethyl pyrophosphate.

Containers and valves proposed for use with low-pressure aerosols by various manufacturers were tested and evaluated. A purchase specification was drafted for a 12-ounce container complete with valve.

Proposed Federal Specifications for Emulsion Concentrates and Wettable Powders Drafted

Proposed specifications were drafted for formulations of several new insecticides. They include emulsion concentrates containing 20 percent of lindane, 45 percent of chlordane, 45 percent of toxaphene, 23 percent of aldrin, and 18 percent of dieldrin, and water-dispersible powders containing 75 percent of DDT, 25 percent of lindane, 25 percent of aldrin, and 25 percent of dieldrin.

Preliminary studies indicate that the concentration of the lindane water-dispersible powder can be increased to 75 percent without loss of its satisfactory physical properties.

The tentative specification for 75-percent DDT water-dispersible power received some minor revisions and was accepted as a Federal specification.

The specification for louse powder also was revised and accepted for Federal use.

Specifications for Botanical Wastes Used as Carriers for Dusts That Protect Grain Prepared

The suitability of several botanical wastes as carriers for insecticides in dusts to be applied to stored grain was tested in one phase

of a study on the utilization of agricultural wastes as diluents or carriers for insecticides. Samples, experimental data, test methods, and other information were exchanged with a company that is experimenting in the development of vegetable materials as carriers for insecticides used in dusting wheat and other grains in storage. Carriers for the purpose should resemble the natural components of the unprocessed grain in order to avoid down-grading due to flavor, health hazard, or appearance. Particular attention was given to the balance between particle fineness and dustability and between adhesiveness to grain and ease of removal in cleaning. Tentative specifications were prepared for botanical carriers. The most important waste or surplus products were evaluated as to their suitability and availability. Ranked in their approximate order of importance, the most outstanding prospects are: Wheat waste, corncobs, English walnut shells, rice hulls, almond shells, peanut hulls, potato flour, and potato starch. Some already are being used by insecticide manufacturers.

New Analytical Procedures for Insecticide Residues Developed

A colorimetric method has been developed for the determination of methoxychlor in milk and fats in amounts as low as 5 micrograms. The methoxychlor is separated from the butterfat of the milk or other fatty material by dissolving the fat in *n*-hexane and extracting the solution several times with nitromethane. The nitromethane extract containing any methoxychlor present is evaporated to remove the solvent. The residue is nitrated with fuming nitric acid and the nitrated product is treated with sodium methylate to produce a color, which is measured with a colorimeter.

Another colorimetric procedure has been worked out for the determination of pyrethrins in paper bags that have been impregnated with pyrethrum for protection against insect attack. As little as 200 micrograms of pyrethrins can be determined quantitatively. The method can be adapted to amounts as small as 25 micrograms with somewhat less accuracy. The impregnated paper is extracted with 95-percent ethyl alcohol. Water is added to the concentrated alcoholic extract, and it, in turn, is extracted with petroleum ether. The petroleum-ether solution is evaporated, the residue is taken up in 95-percent ethyl alcohol, and hydroxylamine hydrochloride and alkali are added. The solution is then treated with hydrochloric acid and ferric chloride. The resulting color is measured with a colorimeter.

A method previously developed by Bureau chemists for determining minute amounts of organic phosphorus compounds based on their cholinesterase-inhibiting properties proved unsatisfactory for the determination of parathion because this insecticide is low in inhibiting properties. By continued study it has been found possible to adapt this method for the determination of parathion by first oxidizing the parathion to its oxygen analog, giving a product which is a strong inhibitor.

New Nicotine Combinations Selected for Field Testing

Twelve of the new combinations of nicotine and other materials found most promising in exploratory tests were selected for more extensive field testing. The exploratory tests were conducted over

the past 8 years in cooperation with the Tobacco Section of the Biochemical Division, Eastern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry.

Insect Cholinesterase Found To Differ From Human Enzyme

The action of the enzyme cholinesterase is inhibited by parathion and other organic phosphates. Continuing studies showed that this enzyme from the heads of house flies, honey bees, and cockroaches differs not only in each insect species but also from that in vertebrates.

HONEY BEES AND OTHER POLLINATING INSECTS

Crop Producers Recognize Their Dependence on Bees

Producers of legume seeds in the West are beginning to realize their dependence on bees and other pollinating insects as did eastern fruit growers some 30 years ago. This is evidenced by the fact that they now seek bees and, contrary to their practice in the past, are willing to pay the beekeeper a cash rental or give him a share in the seed crop for the use of his bees.

Bees still remain in short supply for pollinating purposes. The situation is aggravated by the fact that beekeepers in increasing numbers are going out of business or reducing their holdings because of their inability to operate at a sufficient profit at present prices.

Bees Essential in Cantaloup Production

The need of honey bees for the pollination of cantaloups in Arizona was established by field observations and by cage tests. During 2 days in which the visits of all insect visitors to marked cantaloup flowers in an open field were recorded, 586 honey bees and 4 native bees visited the flowers. In plots caged to exclude honey bees, only 4 marketable melons were obtained from 160 plants. In caged plots of the same size in which bees were confined, 180 marketable melons were produced. Caged plots supplied with an abundance of honey bees gave an estimated 30-percent higher yield than open plots left to be pollinated under prevailing commercial conditions.

The studies were made in cooperation with State and local agencies, with funds authorized under the Research and Marketing Act.

Breeding Queen Bees Distributed

In the bee-breeding project being conducted on Kelleys Island in Lake Erie, in cooperation with The Honey Bee Improvement Cooperative Association, 1,225 hybrid queens were sent to cooperators for test purposes.

Bees in Abundance Needed for High Yield of Red Clover Seed

Yields of red clover seed in 1950 from experimental plots in Ohio pollinated by honey bees ranged from 6.2 bushels to 10.6 bushels an acre. Best yields were obtained from open field plots provided with four colonies of honey bees an acre. The number of pollination visits

made by the bees, based on calculations from the seed obtained, reached 275,400,000 an acre, a new record.

Alfalfa within flight range of a 7-acre field of red clover containing 28 colonies of bees attracted large numbers of field bees of the colonies away from the red clover. There was some indication that the first clover blossoms were not so attractive to the bees as were later ones. Visits to the clover increased when part of the alfalfa was cut.

Bees Selective in Choice of Pollens

In comparative tests on the attractiveness to bees of ground-up bee loads of gumweed pollen, alfalfa pollen, and commercial soybean flour, gumweed pollen was favored over soybean flour. The alfalfa pollen was relatively unattractive.

Moving Bees Means More Seed

In 1950, in a sampled portion of an alfalfa field of 132 acres in California, the estimated acre yield was 1,800 pounds of thresher-run seed. Only slightly more than three colonies of bees an acre were used. The colonies, however, were moved in and out of the field, mostly at intervals of 7 to 10 days, although during part of the time the bees were moved every night. The estimated yield by this method showed an increase of 680 pounds of thresher-run seed over the yield in 1949, when slightly more than five colonies an acre were provided and all colonies were left in their original position for most of the 60-day pollination period.

Ladino Clover Yields Only Pollen to Visiting Bees

Studies at Davis, Calif., showed that the chief activity of bees on ladino clover is pollen collection. The presence of two or three bee visitors to the square yard seemed to insure complete pollination. All blossoms visited closed permanently at nightfall. Other studies on ladino blossoms protected from pollination by honey bees showed that they have no visible nectar for 2 to 3 hours after dehiscence, so that pollen is available in advance of nectar.

Bee-Collected Pollen Usable for Artificial Pollination

Experiments, in cooperation with the Horticultural Department of the University of California, showed that apple pollen stored in a dry-ice freezing chamber will remain viable for a year. Fruit was obtained from apple blossoms to which the stored pollen had been applied by both wet and dry carriers. The fruit set ranged from 4 to 25 percent. The apples had plump, normal appearing seeds, but in number they averaged only about one-third of a full complement. Two freshly hand-collected samples of pollen from Delicious apple blossoms gave a 26- and a 27-percent set, respectively, and fruit with a nearly full complement of seed.

Experiments were also conducted on unstored bee-collected pollen from almond, sweet cherry, pear, and apple trees. The pollen, after being trapped from the colonies, was dried, after which one portion was mixed with lycopodium spores and another with sugar sirup.

The pollens from each fruit gave encouraging sets, although in varying degrees. While wet and dry mixtures of the almond pollen gave comparable results, cherry pollen gave a lower set when applied in a sirup carrier than when applied in a dry carrier.

Habits of Wild Bees Studied

Studies of nesting sites and pollen stores revealed that alkali bees (*Nomia melanderi* Ckll.) in one place flew at least 2 miles to get alfalfa pollen, and that bees from one place collected rabbitbrush pollen but bees from another did not, rabbitbrush being equally abundant in both places.

New Bee Disorder Found

In certain samples of dead brood received for diagnosis from Maryland, Pennsylvania, New Jersey, and Virginia, all the brood had apparently died from the same cause. Affected brood was light yellow. Some of the dead larvae were in uncapped cells; they had assumed curled, twisted positions. Many were in capped cells, the cappings being perforated, as is common in American foulbrood. The dead larvae were easily removed from both capped and uncapped cells. Reversed brood was found in some cells. Examinations failed to reveal the presence of a causative microorganism or virus.

New Insecticides Found Dangerous to Pollinating Insects

Toxaphene dust and spray showed low toxicity in field tests to determine the effect on honey bees of dusts and sprays of DDT, chlordane, and toxaphene applied to alfalfa in bloom, conducted in cooperation with the Utah Agricultural Experiment Station. The applications were made before 7:00 a. m. No mortality from DDT spray at 0.5 pound an acre was observed, but mortality from DDT dust at 0.5 pound an acre was estimated at 5.5 percent. Chlordane spray gave a 10-percent mortality in one test and a 26-percent mortality in a second test. The mortality from chlordane dust was estimated at only 3.6 percent. Chlordane dust, although causing light mortality in this series of tests, had given erratic results in the past. The greater kill from chlordane spray is in line with previous results and indicates that they are more toxic to bees than chlordane dusts.

Observations following widespread application of parathion and less extensive treatments with TEPP to combat a severe outbreak of pea aphis in the Delta area of Utah showed that the main field forces of at least one-third the 14,000 bee colonies in the tract were killed by the insecticides.

Bees May Have Physiological Resistance to American Foulbrood

In tests on resistance to American foulbrood, combs containing eggs from queens of various strains were given to a heavily diseased colony for hatching and rearing to the sealed-brood stage. The sealed brood was then transferred to an incubator to prevent removal of any diseased brood. The amount of disease found in the brood of the different strains showed a fair correlation with the mortality observed in colony-inoculation tests. This variation in the devolpment of Amer-

ican foulbrood in different strains of brood of identical age reared at the same time by the same nurse bees in a heavily diseased colony appears to be evidence that the resistance of some strains is at least partially physiological.

Ultraviolet Light Aids Disease Detection

In many samples of diseased brood comb submitted for laboratory diagnosis it is difficult to locate the brood remains. A simple and rapid method of locating such material has been devised. It is based on the fact that dried larval remains emit a green fluorescence when exposed to ultraviolet light, whereas the comb does not. The contrast between the brood remains and the comb is striking, revealing immediately the presence and location of even minute brood remains.

INSECT IDENTIFICATION

The Bureau provided prompt insect-identification service for farmers, householders, and public and private agencies. Accurate identification is the first step in any attempt to control any insect pest. More than 60,000 samples of insects were identified during the year.

In support of insect identification, and particularly to assure the most accurate and precise identifications possible, research in classification of many insect groups is constantly in progress. Emphasis has been placed on taxonomic studies of spider mites because there is some confusion as to what this group includes and because of the importance of precise identification of forms differing in resistance to certain miticides.

NEMATODES INFESTING POTATOES

Control of Golden Nematode Continued

Golden nematode of potatoes still confined to Long Island

Laboratory processing of soil samples collected in all principal potato-growing areas of the United States failed to disclose any infestations of the golden nematode other than those on Long Island.

Intensive surveys on Long Island showed infestation on 29 additional farms, 20 in Nassau County and 9 in Suffolk County. The most significant find was in a small potato field near Bridgehampton on the south fork of eastern Suffolk County. This isolated find is approximately 60 miles from the nearest previously known infestation.

At the end of June 1951, infestations had been confirmed on 9,800 acres. About 3,600 of these acres have been permanently removed from cultivation because of real-estate developments.

Infestations were found on four properties during a survey of nurseries and retail establishments in Kings, Nassau, Queens, and Suffolk Counties, on Long Island.

Surveys were made in cooperation with 39 States. Nearly 136,800 lots of soil samples, representing soil from 505,000 acres on which white potatoes were planted, were collected at potato-grading, storage, and shipping points and in potato and tomato fields. Samples

were also taken at nurseries in 14 States that had received shipments from foreign countries known to be infested with the golden nematode.

Soil samples were processed to detect cysts of the golden nematode at a headquarters laboratory on Long Island and at 17 temporary sublaboratories scattered through the potato-producing sections of the United States. An important piece of equipment in each laboratory is a mechanical soil washer. With the assistance of the Bureau of Plant Industry, Soils, and Agricultural Engineering, this washer was redesigned into a lightweight portable machine that operates at a lower cost and with greater efficiency.

Regulatory measures function with Federal-State participation

Potato growers on Long Island withheld 2,377 acres of infested land from potato and tomato production under the Federal-State compensation program for the 1950 crop year. Federal payments were limited to lands owned and operated by growers. The State of New York paid an equal per-acre compensation on such lands and assumed all responsibility for compensation on rented lands.

Bureau inspectors cooperated in the enforcement of the New York State golden nematode quarantine. This included supervision of the movement of nearly 270,000 bushels of Irish potatoes and the transportation of 34,000 cubic yards of topsoil.

Chemical treatments were applied in 68 infested nurseries and plant-growing establishments.

Experimental work continued in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and the New York State College of Agriculture for the purpose of developing improved control methods, treating procedures, and equipment.

Further Survey for Potato Rot Nematode in Northwest

Further study of specimens collected in the survey on potato rot nematode early in 1950 resulted in the tentative determination as the potato rot nematode (*Ditylenchus destructor* Thorne) of a single specimen taken in the important bulb-growing area near Mount Vernon, Wash. In an effort to obtain additional specimens for positive determination, further surveys were made in the overlapping potato- and bulb-growing sections of Washington and Oregon, both during and after the 1950 potato harvest. None of the specimens collected in the follow-up survey were infested with this nematode.

Because most Washington-grown potatoes are marketed immediately after harvest, the survey in that State was made during the peak of the harvest, with a supplemental inspection in January 1951 of a few potatoes and iris bulbs in storage. Potatoes from 2,563 of the 3,977 acres planted to potatoes in 11 counties were inspected.

The Oregon survey was also made in January in the potato- and bulb-growing sections around Portland, where potatoes from 1,497 acres in five counties were inspected.

Specimens of potatoes were taken at 55 places in the two States for subsequent examination by nematologists of the Bureau of Plant Industry, Soils, and Agricultural Engineering. The surveys were made in cooperation with State agencies.

JAPANESE BEETLE

Quarantine Activities Expanded

Trap scouting to detect incipient infestations of the Japanese beetle outside the regulated area was carried on in 1,410 localities in 42 States. Beetles were trapped in 204 localities in 16 States. With the exception of the continued occurrence of a small number of beetles at St. Louis, Mo., no beetles were found west of the Mississippi River and no new infestations were found south of North Carolina and Kentucky. Many Bureau field stations, United States military establishments, and State agencies cooperated in the extensive survey.

As a means of controlling the significant infestations discovered, soil treatments were applied on more than 900 acres in 27 localities scattered in 9 States. Foliage was sprayed to kill the adult beetles at 83 locations in 11 States.

A public hearing to consider either the revocation of the quarantine or its extension to include seven additional States was held at Washington, D. C., on March 30, 1951. Based on the testimony at the hearing, a notice was published in the Federal Register on June 21 announcing the Department's intention to continue the quarantine, to amend the quarantine to include the State of North Carolina, to place extensive sections of North Carolina under regulation, and to extend the current regulated areas in New York, Ohio, Pennsylvania, and West Virginia to include all significant infestations discovered in nonregulated sections of these States.

Continued emphasis was given to preventing the spread of the Japanese beetle by aircraft. Approximately 15,400 aerosol treatments of planes were made at 52 airfields within the infested area. An additional 1,600 residual treatments were given military and commercial airplanes at 26 airfields. DDT was applied to vegetation on which the pests might feed or light at 14 commercial and military airfields. This work was done cooperatively by airfield and Bureau employees. Surveys at outlying fields where treated planes landed revealed no new infestations resulting from spread by airplanes. The State of Georgia cooperated in applying control treatments at a previously discovered infestation at the Atlanta, Ga., airport.

Products certified during the fiscal year for movement to points outside the regulated area included more than 116 million plants, 4,450 carloads and truckloads of fresh fruits and vegetables, and 2,000 tons of soil. These had an estimated value of $16,500,000. Growers and shippers treated according to Bureau-approved methods all products likely to be infested.

Seasonal certification requirements for the movement of fruits and vegetables were made effective June 12, 1951. Whereas certification was formerly required for all fruits and vegetables moving by refrigerator car or motortruck, the 1951 requirements were limited to fresh corn on the cob, fresh beans in the pod, cabbage, apples, and peaches. These are the products that are likely to be infested at the time of harvest and to harbor beetles in the commercial pack. They therefore require special treatment or handling to be safe for shipment to noninfested States.

Parasite of Japanese Beetle Well Distributed

Surveys show that the spring Tiphia, *Tiphia vernalis* Rohw., an introduced parasite of grubs of the Japanese beetle, is generally distributed in and near the sections of the East where this species was released. The parasite was introduced from Japan and first liberated here in 1926. Since then it has been released at more than 2,000 points in the area infested by the Japanese beetle. The spring Tiphia was known to have become established at many of the colonization points and to have attained parasitization ranging up to 60 percent or more at these points. Comparatively little was known, however, about its dispersion. To determine the extent of spread, surveys were conducted in 1950 during the flight of the adult Tiphias, in the general area in which colonies had been released in early years. This area included approximately 1,400 square miles in Delaware and southeastern Pennsylvania. Predetermined routes were followed and 10-minute stops made at half-mile intervals without regard to the location of the original colonization points. Even with these brief observation periods adult parasites were seen at 86 percent of the stopping points. Several recoveries were made from 7 to 10 miles beyond the limits of the area where colonies had been released. It is evident that the parasite has spread through and beyond the entire area that has been generally colonized, thereby demonstrating a capacity for unaided dispersion.

Biological Assay Method for DDT and Chlordane Residues in Soil Developed

A tentative procedure for determining, by biological tests, the amount of residues of DDT and chlordane in the soil has been developed at the Moorestown, N. J., laboratory. These insecticides are used in the soil to kill Japanese beetle grubs. When soil is treated with them as a means of authorizing the movement of nursery stock from infested to uninfested areas, it is necessary to determine annually how much of the chemical remains in the soil from earlier treatments. The test insect used in this assay is *Macrocentrus ancylivorus* Rohw., a wasplike parasite of the oriental fruit moth. The method is based on the reactions of the parasite to small amounts of chlorinated hydrocarbon insecticide in extracts of the treated soil. Small variations in the amounts of these materials present cause significant differences in the time required to kill the test insects. Indications are that DDT and chlordane residues in soil can be assayed whether they occur separately or in combination. It may also be possible to use this method to determine amounts of other chlorinated hydrocarbon insecticides, such as aldrin and dieldrin, in the soil.

WHITE-FRINGED BEETLES

White-Fringed Beetle Numbers Reduced in All Areas

Twenty-two counties known to have been infested by the white-fringed beetle were found free of the beetle in this year's scouting. In a few of the counties this was the second year of negative findings.

Surveys outside the known infested areas revealed infestations in four counties. The new finds were in areas adjacent to infested counties.

Other surveys to determine the abundance of beetles showed that numbers in all infested areas are lower than in previous years. This reduction is believed due to the cumulative effect of DDT treatments of soil in nurseries and on farms, supplemented by DDT foilage sprays.

Extensive Farm-Land Areas Treated to Destroy White-Fringed Beetles

With the completion of soil treatments this year, some 38,000 acres, or about half of the farm lands known to be infested with white-fringed beetles, have been treated with DDT at the rate of 10 pounds an acre. The work has been in progress since 1946. This dosage will control the beetle for approximately 6 years. Farmers were urged to supplement the residues in the treated fields by adding DDT to the commercial fertilizers applied in the fields. About half of the acreage that had been soil-treated received a supplementary treatment of DDT mixed with commercial fertilizer. By following a program of annual applications of DDT with fertilizers it is anticipated that it will be possible to keep the DDT residues high enough to prevent reinvasion of treated fields.

DDT Treatments of Soil Qualify Some Crops for Certification

Treatment of infested farm land with 10 pounds of DDT an acre was approved as a condition for the certification for interstate movement of soybeans, lupine, Irish potatoes, and grass and legume seed. A waiting period of approximately 1 year following the treatment is required before crops produced on the land are eligible for certification. Approximately 90 percent of the infested farm land in Alabama devoted to the production of Irish potatoes and a sizable portion of the soybean land have been treated. Farmers readily accept the treatment, for it economically protects their crops against injury by the beetle larvae and at the same time renders their crops eligible for movement without further treatment.

Alternate for DDT as Certification Treatment Sought

Chlordane added to nursery soil a year ago at rates of 5 or more pounds an acre prevented the establishment of white-fringed beetle larvae. Certain plants intolerant to DDT tolerated the chlordane treatment in plot tests. These observations were made as part of continuing investigations to determine whether chlordane can be used as an alternate to DDT at 50 pounds an acre, now authorized for certification under the regulations.

Tests to determine the tolerance of strawberry plants to such DDT treatments showed that DDT prevented normal plant development and reduced berry production. The reduction in yield was directly proportional to the amount of DDT added to the soil. At 50 pounds an acre there was a one-third reduction in yield.

FOREIGN PLANT QUARANTINE ACTIVITIES

Injurious Pests Caught Before Entry

During the year, 151,000 lots of prohibited or restricted plants and plant products were intercepted, an increase of more than 6 percent over 1950. Interceptions numbered 95,000 from passengers' baggage, 3,300 from cargo, 3,500 in mail, 17,100 in ships' quarters, and 32,100 in ships' stores. In this huge quantity of intercepted material there were 10,850 insect infestations and 6,710 plant-disease infections.

Among the injurious insects intercepted were the olive, oriental, Mexican, West Indian, Mediterranean, and three other species of fruit flies, the citrus blackfly, and nine species of whiteflies, the mango weevil, pink bollworm, and several lepidopterous pests of beans and grapes.

Fungus diseases intercepted included: Black spot of citrus, Australian citrus scab, sweet orange scab; Cercospora diseases of banana, orchid, cotton, onion, rhododendron, persimmon, pomegranate, mango, oleander, laurel, and palm; rusts of rhododendron, juniper, quince, boxwood, chrysanthemum, bird-of-paradise, and cherry. Virus diseases were intercepted on tomato, crossandra, and camellia. Bacterial diseases were found on endive, hyacinth, olive, oleander, and citrus. Nematodes intercepted included many specimens of the golden nematode in soil with plant parts, as well as the oat nematode of the same genus.

Carriers Inspected

Maritime traffic was almost 6 percent heavier than during the previous year, owing in part to large-scale passenger travel and a growing volume of foreign commerce. Of the 47,600 incoming vessels 44,350 were given plant quarantine inspection. Injurious insect pests and plant diseases intercepted included such harmful species as the golden nematode, giant African snail, several species of fruit flies, potato weevils, avocado weevils, and citrus canker. It was again necessary to treat or otherwise safeguard cargoes of military equipment returned from the Pacific because of infestation with the giant African snail. This was accomplished through the cooperation of the transportation agencies and importers. The golden nematode presented a particularly difficult problem in that it was frequently found with minute quantities of soil on root crops carried in ships' stores and associated with other miscellaneous materials upon which it does not feed and where its presence would not ordinarily be suspected.

Nearly 70,000 planes were inspected at ports of entry, an increase of 21 percent over the previous year. Almost one-third of these were carrying contraband plant material originating in many foreign countries and destined to points throughout the United States. Air traffic from the Orient, both through Honolulu and by way of Alaska, was exceptionally heavy.

The inspection and certification of fruits and vegetables for movement from Hawaii to the mainland again increased sharply as a result of approval of new treatments lethal to the oriental fruit fly

and other pests of the Islands. More than 131,000 boxes and other containers were certified after such treatment. Inspectors in Hawaii inspected 12,400 pieces of baggage, some in automobile trunks, and sealed them prior to departure to the mainland by ship. They also examined 527,000 packages of cut flowers and leis destined for continental United States. After inspection and treatment with a DDT aerosol 8,250 planes leaving Hawaii for the mainland were granted preflight clearance. This clearance followed the removal of unauthorized plant material from the passenger or baggage compartments of more than two-thirds of the planes.

Plant quarantine activities in Puerto Rico showed an increase similar to that in Hawaii. Twenty-two thousand boxes and other containers of fruits and vegetables moved under certification from Puerto Rico to the mainland. Large numbers of agricultural workers flown to the mainland in a "labor airlift" brought about a large increase in the preflight inspection of aircraft in Puerto Rico. Nearly 4,600 planes were cleared prior to departure. This involved the examination of 292,000 pieces of passenger's baggage, nearly half of which would have carried unauthorized plant material to the continental United States had it not been intercepted.

Safeguarding vehicular and rail traffic from Mexico assumed added importance because of the growing threat of the entry of the citrus blackfly and other pests from that country. During the year 10,328,-300 vehicles were inspected at border ports of entry. This represents an increase of nearly 23 percent over 1950, which had also been a record year for such traffic. Inspection was maintained around the clock at strategic ports connected with the interior of Mexico by paved highways. The need for vigilance on this front was evidenced by the frequent interception of such pests as the citrus blackfly, the Mexican and other fruit flies, the pink bollworm, an Irish potato weevil, and avocado weevils.

Range riders of the Bureau of Animal Industry, patrolling the Mexican border to prevent the entry of animals or products likely to carry foot-and-mouth disease, apprehended some aliens with contraband plant material. Of special importance was an interception of citrus leaves infested with citrus blackfly from an alien who had reached the citrus belt of the Lower Rio Grande Valley.

A total of 76,000 freight cars were examined in Mexico prior to crossing the border, an increase of 10 percent over 1950, and 3,421 pullman and passenger coaches were inspected at the border. It was necessary to fumigate only 359 freight cars as a condition of entry, as a result of the recent modification of fumigation requirements to take advantage of changed pest conditions in Mexico resulting from the Bureau's cooperative work in that country. The Bureau's cooperative program with Mexico to prevent the spread of pests from the mainland to Baja California, was effective in protecting both the west coast of Mexico and California and other sections of the United States. Experience acquired during the brief period this project has been in operation has permitted the strengthening of defenses against the westward spread in Mexico of the pink bollworm, Mexican fruit fly, citrus blackfly, boll weevil, and other major pests.

Mail Inspected

The threat to our agriculture from pests arriving in the mails was demonstrated repeatedly. Among the more destructive forms taken were a weevil pest of apples, the golden nematode, the Mediterranean fruit fly, the olive fly, the oriental fruit fly, a weevil attacking filberts, and an important disease of citrus. Of the 2,062,600 foreign parcel-post packages examined, 3,000 contained unauthorized plant material and 4,600 packages of plants and plant products were released under permit. In Hawaii 367,700 packages were examined prior to dispatch to the mainland, 143,260 of which were opened for inspection. A total of 96,000 packages destined for the mainland were examined in Puerto Rico; 6,825 of them were opened for inspection.

Imported Plant Products Inspected

Importations of plants and plant products under permit continued heavy throughout the year; 258,932,200 crates, boxes, bales, bushels, bunches, and other units were inspected at ports of entry and treated or otherwise safeguarded when pest conditions warranted. Importations included nursery stock, plants, seeds, fruits, vegetables, cotton and cotton products, cereals, and fibers. In addition, millions of small lots of plant material imported from Mexico were inspected and safeguarded, if necessary, but not recorded. There was an increased interest on the part of the trade in importing under treatment fruits which otherwise would be prohibited because of fruit-fly risk. Large quantities of deciduous fruits were entered from South Africa and Argentina subject to cold treatment and a large volume of citrus fruit was imported from Mexico after vapor-heat treatment.

A total of 784 shipments of plants, seeds, and other propagating materials were imported by the Department for scientific and experimental purposes. They were examined and treated, when required by pest conditions, at the inspection house in Washington, D. C. Certain plants considered capable of harboring pests that could not be detected at the time of importation were grown for a period under quarantine, during which they were regularly examined. Final inspection prior to release was made of 39,170 exotic plants and 7,420 budsticks and cuttings grown by the Department under quarantine conditions.

Plant Material Grown Under Postentry Quarantine

Field inspections of imported plants being grown under postentry quarantine demonstrated the importance of keeping certain classes of plants under surveillance long enough to determine whether they are infected or infested with pests not detectable at the time of entry. An injurious whitefly and a scale insect, neither of which is known to occur in the continental United States, were found on *Jasminum* plants from the Philippines being grown under quarantine. The plants were promptly refumigated. Postentry inspection also uncovered five important virus diseases, including two of hops, one of *Laburnum vosii*, one of flowering cherry, and one of *Daphne mezereum*. The infected plants were either destroyed or rogued and held under quarantine for further observation.

A total of 600 shipments of plants, consisting of 1,447,662 units, were imported for growth under postentry quarantine and 264,442 plants were released after having been kept under observation for the required period. Frequent contacts were again made with State officials, and field inspections of plant material grown in detention were made in cooperation with them.

Imported Plant Material Treated

In addition to the fruits and vegetables treated in transit, in Hawaii and Puerto Rico before movement to the mainland, and in Mexico before shipment to the United States, large quantities of plants, plant products, and even nonagricultural material had to be fumigated or otherwise treated upon arrival to eliminate plant pests. A total of 1,064,000 bales and 2,700 containers of cotton lint, linters, and bagging, 2,025 containers of cottonseed cake and meal, and 26,260 cotton samples were fumigated. Treatment was also required as a condition of entry for 228,200 containers of fruits and vegetables, 83,500 bales of broomcorn, 52,800 containers of chestnuts, cipollini, and pigeonpeas, 2,243,700 units and 25,900 containers of plants, cuttings, bulbs, roots, and other propagating materials, 23,100 pounds and 5,560 containers of seeds, 735 bales of fiber, and 297,700 lots of miscellaneous plant products. In addition, 84,800 bales of cotton lint, linters, and waste were utilized in approved northern mills in lieu of fumigation. It was also necessary to treat or clean 19,000 pieces of returned military equipment, because of the presence of the giant African snail, and 257 tons of steel contaminated with cotton waste.

Plants and Plant Products Certified for Export

As with most other plant quarantine activities, there was a marked increase in the inspection and certification of plants and plant products to meet the import requirements of the countries of destination. During the year 20,533 export certificates were issued, covering 9,095,135 containers. The certificates were issued at 45 ports and covered 146 commodities consigned to 124 foreign countries. Beginning January 1, 1951, Venezuela required inspection and certification of all flour consigned to that country, which accounted in part for the increase in this activity.

TRANSIT INSPECTION

Effective February 1, 1951, transit-inspection activities were transferred from the Division of Domestic Plant Quarantines to the Division of Foreign Plant Quarantines and prompt steps were taken to integrate the activities at places where both transit and foreign plant quarantine inspections have been conducted in the past. At other stations steps were taken to extend the sphere of transit inspection to include the examination of mail shipments of foreign origin and other foreign plant quarantine work. Inspections were made of more than 1,522,000 shipments of quarantined material moving in interstate or intrastate commerce; 1,711 shipments were found to be mov-

ing in apparent violation of Federal domestic quarantines or State quarantines, including those against the pink bollworm, sweetpotato weevil, peach mosaic, gypsy moth, and Japanese beetle, in the enforcement of which the Bureau of Entomology and Plant Quarantine cooperates. These shipments were consigned to 42 States and the District of Columbia. Transit inspectors observed 302 shipments moving in apparent violation of State nursery-inspection certification requirements or State quarantines and reported them to the States concerned.

Transit inspection was carried out at 17 major transportation centers strategically located with respect to the long-distance movement of regulated articles from regulated areas. Inspectors of the white-fringed beetle projects and State inspectors in California, Florida, and Michigan cooperated in the work.

INSPECTION SERVICE IN DISTRICT OF COLUMBIA CONTINUED

Examination was made of 48,423 shipments of plants entering the District of Columbia to determine whether they were certified and free from insect pests and plant diseases. Of these, 25 shipments lacked the required State certification, and 4 were destroyed or returned to the sender because pests were present. Certificates were issued for 742 shipments containing 39,600 plants sent from the District of Columbia to 44 States, Hawaii, Puerto Rico, and the Dominion of Canada. In these shipments inspectors found 19 kinds of insect pests, 1 species of nemotode, and 15 plant diseases. Diseased or infested plants were treated when possible, destroyed, or returned to the shipper.

Forty-seven trucks bringing potted plants or nursery stock into the District were intercepted. With few exceptions all truckers had valid inspection certificates for their stock. Truckers failing to carry certificates of inspection were released on evidence that the stock was eligible for certification. One truck shipment was destroyed because of a severe plant-pest infestation.

DESTRUCTION OF KLAMATH WEED BY IMPORTED INSECTS

Destruction of the Klamath weed in northern California by the two foliage-feeding *Chrysolina* beetles imported from Australia in 1944 and succeeding years has progressively increased. The weed is now extremely scarce in an area of approximately 100 square miles near the original points of beetle release in Humboldt County. During the year several million *Chrysolina gemellata* were collected in this county for redistribution within Humboldt and 14 other counties. This species has also increased in southern Oregon until it can now be redistributed within that State.

The Klamath weed root borer *Agrilus hyperici* Creutz. and the gall fly *Zeuxidiplosis giardi* Kieff., both imported early in 1950, have become established in the California mountainous areas where *Chrysolina* is not fully effective.

CONTROL OF PLANT DISEASES

Campaign Against White Pine Blister Rust Continued

Blister rust under control in wide area

Progress in ribes eradication by cooperating Federal, State, and private agencies has brought blister rust under control on more than half of the area in the work program. This condition was maintained by periodic examination and removal of ribes bushes from affected areas and by enforcement of quarantine regulations to prevent replanting and subsequent escape and establishment of cultivated bushes in protected areas. Control of the disease has reached this maintenance status on all important pine plantings in Delaware, New Jersey, Maryland, Kentucky, Tennessee, Georgia, South Carolina, Connecticut, Rhode Island, and Massachusetts.

Disease-control conditions were maintained around 20 forest-tree nurseries containing about 37 million white pines to provide rust-free planting stock. This required the removal of only 26,481 ribes bushes from 9,185 acres of land, or an average of less than 3 bushes an acre, indicating a high degree of protection.

Experiments with fog application of light dosages of 2,4–D in a helicopter showed enough promise of lowering costs of ribes eradication on some sites to warrant further tests. Methods of treating ribes stems with 2,4-D and 2,4,5-T dissolved in Diesel oil were improved as a result of more precise data on dosage, formulations, and equipment accessories. Studies on ribes ecology in relation to cutting practices, pine regeneration, prescribed burning, and broadcast and selective application of herbicides were continued in cooperation with the Forest Service.

Work efficiency increased by improved methods

Improved hand and chemical methods of ribes eradication have increased production and efficiency in cooperative control operations. The one-man method of ribes eradication is now well established in all regions and more work of better quality has been obtained with additional experience in its use.

Ribes eradication on more than 40,000 acres of white pine land was contracted to individuals on a bid basis in the western white and sugar pine regions. About 49 percent of the ribes-eradication work in the sugar pine region and 9 percent in the western white pine region was done by contract. Where it can be used effectively, this method is cheaper than camp operations on ribes sites. It is not used in the East, where local labor is employed.

Ribes removed on nearly 1,400,000 acres

The cooperating agencies, under Bureau leadership and technical direction, destroyed more than 18 million ribes bushes on nearly 1,400,000 acres of land to protect valuable white pine stands. About three-fourths of this work involved removal of ribes regrowth on partially protected areas. Seasonal employees used on ribes eradication numbered 3,430, and 63 camps were operated in remote forest areas to carry on the field work. Also, nearly 41,000 rust-infected white pine trees in forest plantings were saved from destruction by cutting off the diseased parts.

Ribes destroyed with chemicals

Several kinds of equipment, such as power sprayer, turbine blower, knapsack, Hi-Fog gun, and helicopter, were used by the cooperating agencies in applying 2,4-D and 2,4,5-T to destroy millions of ribes bushes on about 5,190 acres in the western white and sugar pine regions. Increasing use was made of chemicals to destroy ribes on logged-over, burnt, upland, and stream-type areas. Concentrations of ribes on these sites can be effectively treated with chemicals at a fraction of the cost of other methods. Only minor use of chemicals is feasible in eastern white pine regions, where chemicals were most effective in destroying large patches of wild black currant bushes. This was accomplished at about one-fourth the cost of hand methods.

The Bureau cooperated with the School of Forestry of the University of California and the California Forest and Range Experiment Station in an economic study of sugar pine management in the Pacific coast region. Economic standards were developed for selecting stands for protection against blister rust. They were integrated with climate and disease-survey information and techniques were developed for their application. Applied on a practical basis to 147,000 acres of sugar pine lands, they brought about the reduction of protective zones and the selection of small, highly productive sugar pine stands for blister-rust control treatment. The stands were previously excluded from control areas because of the high cost of working surrounding protective zones.

Studies initiated on rust resistance in white pines

A search for western white pines apparently resistant to blister rust revealed 59 such trees. From them 2,000 scions were taken and grafted on white pine seedling transplant stock. With assistance from the Institute of Forest Genetics, California Forest and Range Experiment Station, 420 controlled pollinations were made between 25 of the resistant trees. They included 80 different crosses between rust-resistant white pine trees. The progeny from the crosses will be used for determining the inheritance of rust resistance.

Studies were started to determine whether the blister rust fungus develops physiological races and, if so, whether they differ pathologically in their ability to attack different species and varieties of white pines. The studies, carried on cooperatively by the University of Minnesota and the Bureau of Plant Industry, Soils, and Agricultural Engineering, are related to the development of rust resistance in white pines.

Rust found in new places

Blister rust was found on white pines for the first time in Ravalli County, Mont., Lemhi County, Idaho, Park County, Wyo., Missouke County, Mich., and Amherst County, Va. A small infection center was found in Big Canyon drainage at the southern end of the Eldorado National Forest in California, which extends the infected area 7 miles southward. From the Lassen Forest northward in California, surveys show that outside control areas the disease is rapidly increasing on pines. On ribes bushes, the rust was found in Cascade County, Mont., Lemhi County, Idaho, and Park County, Wyo.

Barberry Eradicated to Control Stem Rust

New races of rust cause local grain losses

Wide occurrence of highly virulent new races of the wheat and oat varieties of stem rust caused serious grain losses in 1950. This disease reduced late crops of durum wheat in North Dakota and Minnesota by about 20 percent, or an estimated 10 million bushels. Late fields of hard spring wheat also were seriously damaged. Oat losses amounted to several million bushels in Iowa, Illinois, and Wisconsin. They were caused by race 15B of the wheat-stem rust and race 7 of the oat-stem rust, both of which originated on barberry plants. These races can attack and damage all the important commercial varieties of wheat and oats. In past years both races were found occasionally near barberry bushes in the East. In 1950 they appeared in many States, causing severe damage to late crops of wheat and oats.

More than 20 million barberry plants killed

More than 20 million native and introduced rust-spreading barberry bushes were killed in 284 counties in 18 cooperating States and 31,261 square miles were freed of barberry. Barberry sites within an area of 5,000 square miles that became reinfested during the war years were completely reworked.

Territory freed of barberries kept free

More than 80 percent of the area in the 18 barberry-eradication States has been freed of rust-spreading bushes and is being kept free of them. This is accomplished by nursery inspection, quarantine enforcement, disease surveys, recheck of previously infested properties, and encouragement to farmers to promptly report any barberry plants they may find. No further organized searching for barberries is contemplated in these areas unless some bushes are reported or located through maintenance activities.

Territory freed of barberries includes areas found free of the plants when initially examined and barberry-infested sites worked at periodic intervals until permanently cleared of the plants. All territory in what is termed a control area is initially examined for barberry. Sites found infested are systematically searched and all rust-spreading barberries are destroyed. These places are reworked at 5- to 7-year intervals to remove any seedling plants before they are old enough to seed and reinfest the territory. About three workings are necessary before infested sites can be freed of barberries and placed on maintenance because seeds in the soil can remain viable for 12 years. Reworking at intervals allows time for seeds to germinate and new plants to become large enough to be found, yet not old enough to produce seed. These practices systematically exhaust seed sources and rid areas of barberries. Many years of practical experience have demonstrated their effectiveness.

New movie stimulates control

A new color-sound movie film, "Stem Rust—Airborne Enemy of Grain," was released. Copies were sent to 35 film libraries in the control States. The film was shown at 286 meetings and seen by about 15,000 people in 1950.

Chemicals and power sprayers reduce eradication costs

Effective formulations of hormone-type sprays were used to kill native barberries in Colorado, Virginia, and West Virginia. The sprays were applied with special compressed-air equipment. This method of destroying native barberries reduced the cost of the work by about 60 percent and hastened its progress.

Tests were run in an effort to find a more effective chemical for destroying the common barberry, *Berberis vulgaris*. It can be effectively killed with ammonium sulfamate, but the application of this chemical is too slow and costs too much where barberries are numerous. Some formulations of 2,4-D and 2,4,5-T, tried as a foilage spray and basal-stem treatment, look promising.

Trial flights were made to determine the practicability of using the helicopter for barberry surveys. Based on two tests, it appears that some sites can be initially surveyed by this method economically and effectively. More tests are needed to determine its place in barberry-eradication work, however.

Nurseries inspected for rust-susceptible barberry

Barberry plants were inspected in 257 nurseries in 37 States. These nurseries and 39 dealers were authorized to move interstate approved rust-resistant barberry and mahonia plants. The nurseries examined had 17 million barberry and mahonia plants, of which 1,236 were susceptible to stem rust. Nurserymen cooperated effectively by promptly destroying the susceptible plants. Most nurserymen now produce their own barberry seed and grow only rust-resistant barberry plants. This further reduces the possibility of rust-spreading barberry plants being distributed in the nursery trade.

Organization changed

Organization changes are made in barberry eradication as the work reaches a maintenance status in the cooperating States. This has resulted in combining the maintenance activities in two States under one individual. Five such combinations, involving 10 States, have been made.

Campaign Against Insect Vectors of Peach Diseases Continued

Destruction of leafhoppers may control spread of phony peach disease

Preliminary observations of peach trees that had been sprayed with DDT in 1947 and 1948 indicate that it may be possible to control the natural spread of phony peach disease with sprays that destroy the leafhopper carriers of the disease virus. The observations were made in two peach orchards near Fort Valley, Ga. Part of each orchard received the DDT sprays; part did not. In 1950 the sprayed trees developed fewer cases of phony peach than the unsprayed trees.

In addition to these experiments, a large-scale spraying program in the Fort Valley area was continued for a second year. Ninety thousand peach trees in an isolated area were sprayed with DDT. As the virus causing the disease may require as long as 3 years for incubation, the full results of this work cannot be observed until 1952 or later.

Research findings applied to eradication of phony peach

Annual roguing of peach trees infected with the phony peach disease in a single orchard will not eliminate the disease or appreciably reduce it in areas of serious infection and rapid natural spread, recent studies have shown. Only when roguing is practiced in all orchards in an area is the disease sufficiently inhibited to allow profitable operations. Area-wide roguing materially delays infection in new plantings. If the disease develops unchecked, the number of infected trees increases so rapidly that orchard plantings are no longer profitable.

Soaking cut sections of wood from the tops of peach trees in acidulated methanol may give the same evidence of the presence of phony peach disease virus as when this test is applied to sections of the root. Plant pathologists perfected the root-section test many years ago. When phony peach virus is present, the cut section shows purplish spots in the wood. Trials of the top-wood method with trees used in insect-transmission tests indicate that phony peach in small trees may be diagnosed in as short a period as 6 months, in contrast to the 2 or 3 years required when diagnosis is based on the development of visual symptoms in infected trees. If studies now in progress continue to show that the chemical test is dependable, the studies of the transmission of this disease by insects can be greatly accelerated. There will also be a great saving in greenhouse space—an expensive item in the research program dealing with insect transmission of the disease.

These tests are being carried on in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering.

Using the new diagnostic technique, a preliminary survey for the presence of phony peach in wild plum was made. Plums appear to tolerate the disease while masking visual symptoms. The limited sampling of the preliminary work showed that the disease occurs in wild plum in widely scattered localities in the infected States.

Infected States revised their phony peach disease quarantines to conform to the new developments and to the previously announced findings that leafhoppers are vectors of the disease.

Phony peach infections were found on 1,051 properties in 65 counties during the calendar year 1950. More than 57,000 trees showed disease symptoms. There was a marked reduction from the 1949 incidence of the disease in Alabama, Arkansas, Louisiana, Missouri, South Carolina, and Texas. There was no significant change in Georgia, Mississippi, and Tennessee. Lowndes County, Miss., Shelby County, Tenn., and Kerr and Upshur Counties, Tex., were found free from infection and were removed from State quarantine.

Peach mosaic at all-time low

An all-time low in peach mosaic was disclosed by inspectors during the calendar year 1950. This reduction was general except in southwestern Arkansas, where the first comprehensive survey in that area showed an increase. More than 4,400 trees on 970 properties scattered in 16 counties of 6 States were found infected.

Surveys Show Louisiana and Texas Still Free of Citrus Canker

Completion of the second phase of a 3-year cooperative Federal-State citrus canker survey in Louisiana disclosed no evidence of the disease. This year's activities consisted of a survey of abandoned and escaped citrus trees along the bayous and in swamp areas in parishes where canker infection had been found at any time since 1935. One State and two Federal inspectors were engaged in this survey from October 9 until December 2, 1950. More than 20,000 citrus trees were examined on 2,300 properties in 8 parishes. Most of the trees were so seriously infected with scale and red fungus that inspection for canker was difficult. Two previously infected properties far out in the marshes of Terrebonne Parish, where citrus canker was found in 1936 and 1939, were reached by boat for thorough reinspections and no canker was found.

Areas in Texas where citrus-canker infections were found between 1935 and 1943 were reexamined with no canker being found. Most of the work was in the vicinity of Alvin in Brazoria County, Alta Loma in Galveston County, and Navasota in Grimes County. Canker infection was last found in Texas in 1943 at Navasota on a small *Poncirus trifoliata* seedling on a property which was originally found infected in 1941. Two previously infected properties in Corpus Christi and six near Hamshire in Jefferson County were also given close inspection. A number of old *P. trifoliata* hedges in Washington and Montgomery Counties were inspected. Approximately 208,000 citrus trees on nearly 700 properties in 10 counties were inspected.

Dutch Elm Disease Reported From Three More States

Out of a total of 5,124 elm specimens submitted to the Dutch elm disease service laboratory for culturing, the disease was identified in 3,868 sets of specimens. The identifications confirmed the presence of the disease in 15 States and the District of Columbia. Specimens for culturing were submitted by 16 Federal, 37 State, and 49 local Government agencies, 63 arborists, and 102 institutions and property owners, in 21 States and the District of Columbia.

The Dutch elm disease fungus was found for the first time, in August 1950, in Illinois, Michigan, and New Hampshire. The disease reappeared in Rhode Island, where it had not been found since 1946. A heavy outbreak was discovered in the Pittsburgh, Pa., area. In the District of Columbia and adjoining area, 1950 confirmations tripled those of the previous year. When control work was discontinued in Indianapolis in 1943, only two diseased trees could be found there. Elms died there by the hundreds in 1950. There was no reported recurrence of the disease in Colorado in 1950.

Technical assistance was furnished the Michigan Department of Agriculture in initiating a Dutch elm disease scouting and control program in the Detroit area.

Directions for detecting diseased trees, containers for forwarding specimens, and educational displays were furnished various agencies in 15 States.

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